August 15th, 1939

Dr. Alexander Sachs
One William Street
New York City

Dear Dr. Sachs:

Enclosed I am sending you a letter from Prof. Albert Einstein, which is addressed to President Roosevelt and which he sent to me with the request of forwarding it through such channels as might appear appropriate. If you see your way to bring this letter to the attention of the President, I am certain Prof. Einstein would appreciate your doing so; otherwise would you be good enough to return the letter to me?

If a man, having courage and imagination, could be found and if such a man were put - in accordance with Dr. Einstein's suggestion - in the position to act with some measure of authority in this matter, this would certainly be an important step forward. In order that you may be able to see of what assistance such a man could be in our work, allow me please to give you a short account of the past history of the case.

In January this year, when I realized that there was a remote possibility of setting up a chain reaction in a large mass of uranium, I communicated with Prof. E.P. Wigner of Princeton University and Prof. E. Teller of George Washington University, Washington, D.C., and the three of us remained in constant consultation ever since. First of all it appeared necessary to perform certain fundamental experiments for which the use of about one gram of radium was required. Since at that time we had no certainty and had to act on a remote possibility, we could hardly hope to succeed in persuading a university laboratory to take charge of these experiments, or even to acquire the radium needed. Attempts to obtain the necessary funds from other sources appeared to be equally hopeless. In these circumstances a few of us physicists formed an association, called "Association for Scientific Collaboration", collected some funds among ourselves, rented about one gram of radium, and I arranged with the Physics Department of Columbia University for their permission to carry out the proposed experiments at Columbia. These experiments led early in March to rather striking results.

At about the same time Prof. E. Fermi, also at Columbia, made experiments of his own, independently of ours, and came to identical

conclusions.

A close collaboration arose out of this coincidence, and recently Dr. Fermi and I jointly performed experiments which make it appear probable that a chain reaction in uranium can be achieved in the immediate future.

The path along which we have to move is now clearly defined, but it takes some courage to embark on the journey. The experiments will be costly since we will now have to work with tons of material rather than - as hitherto - with kilograms. Two or possibly three different alternatives will have to be tried; failures, set-backs and some unavoidable danger to human life will have to be faced. We have so far made use of the Association for Scientific Collaboration to overcome the difficulty of persuading other organisations to take financial risks, and also to overvome the general reluctance to take action on the basis of probabilities in the absence of certainty. Now, in the face of greater certainty, but also greater risks, it will become necessary either to strengthen this association both morally and financially, or to find new ways which would serve the same purpose. We have to approach as quickly as possible public-spirited private persons and try to enlist their financial co-operation, or, failing in this, we would have to try to enlist the collaboration of the leading firms of the electrical or chemical industry.

Other aspects of the situation have to be kept in mind. Dr. Wigner is taking the stand that it is our duty to enlist the co-operation of the Administration. A few weeks ago he came to New York in order to discuss this point with Dr. Teller and me, and on his initiative conversations took place between Dr. Einstein and the three of us. This led to Dr. Einstein's decision to write to the President.

I am enclosing memorandum which will give you some of the views and opinions which were expressed in these conversations.

I wish to make it clear that,in approaching you,I am acting in the capacity of a trustee of the Association for Scientific Collaboration, and that I have no authority to speak in the name of the Physics Department of Columbia University, of which I am a guest.

Yours sincerely,

(Leo Szilard)

B-17

August 25th, 1939

Dr. Alexander Sachs
One William Street
New York City

Dear Dr. Sachs:

Enclosed you will find a copy of the memorandum containing the changes which you suggested. I am also enclosing two copies of a reprint. Reprints of my joint paper with Fermi will be sent to you as soon as I receive them.

Yours sincerely,

(Leo Szilard)

MEMORANDUM

August 15th, 1939

Much experimentation on atomic desintegration was done during the past five years, but up to this year the problem of liberating nuclear energy could not be attacked with any reasonable hope for success. Early this year it became known that the element uranium can be split by neutrons. It appeared conceivable that in this nuclear process uranium itself may emit neutrons, and a few of us envisaged the possibility of liberating nuclear energy by means of a chain reaction of neutrons in uranium.

Experiments were thereupon performed, which led to striking results. One has to conclude that a nuclear chain reaction could be maintained under certain well defined conditions in a large mass of uranium. It still remains to prove this conclusion by actually setting up such a chain reaction in a large-scale experiment.

This new development in physics means that a new source of power is now being created. Large amounts of energy would be liberated, and large quantities of new radioactive elements would be produced in such a chain reaction.

In medical applications of radium we have to deal with quantities of grams; the new radioactive elements could be produced in the chain reaction in quantities corresponding to tons of radium equivalents. While the practical application would include the medical field, it would not be limited to it.

A radioactive element gives a continuous release of energy for a certain period of time. The amount of energy which is released per unit weight of material may be very large, and therefore such elements might

be used - if available in large quantities - as a fuel for driving boats or airplanes. It should be pointed out however that the physiological action of the radiations emitted by these new radioactive elements makes it necessary to protect those who have to stay close to a large quantity of such an element, for instance the driver of the airplane. It may therefore be necessary to carry large quantities of lead, and this necessity might impede a development along this line, or at least limit the field of application.

Large quantities of energy would be liberated in a chain reaction, which might be utilized for purposes of power production in the form of a stationary power plant.

In view of this development it may be a question of national importance to secure an adequate supply of uranium. The United States has only very poor ores of uranium in moderate quantitées; there is a good ore of uranium in Canada where the total deposit is estimated to be about 3000 tons; there may be about 1500 tons of uranium in Czechoslovakia, which is now controlled by Germany; there is an unknown amount of uranium in Russia, but the most important source of uranium, consisting of an unknown but probably very large amount of good ore, is Belgian Congo.

It is suggested therefore to explore the possibility of bringing over from Belgium or Belgian Congo a large stock of pitchblend, which is the ore of both radium and uranium, and to keep this stock here for possible future use. Perhaps a large quantity of this ore might be obtained as a token reparation payment from the Belgian Government. In taking action along this line it would not be necessary officially to disclose that the uranium content of the ore is the point of interest; action might be taken on the ground that it is of value to secure a stock of the ore on account of its radium content for possible future

extraction of the radium for medical purposes.

Since it is unlikely that an earnest attempt to secure a supply of uranium will be made before the possibility of a chain reaction has been visibly demonstrated, it appears necessary to do this as quickly as possible by performing a large-scale experiment. The previous experiments have prepared the ground to the extent that it is now possible clearly to define the conditions under which such a large-scale experiment would have to be carried out. Still two or three different set-ups may have to be tried out, or alternatively preliminary experiments have to be carried out with several tons of material if we want to decide in advance in favor of one set-up or another. These experiments cannot be carried out within the limited budget which was provided for laboratory experiments in the past, and it has now become necessary either to strengthen - financially and otherwise - the organizations which concerned themselves with this work up to now, or to create some new organization for the purpose. Public-spirited private persons who are likely to be interested in supporting this enterprise should be approached without delay, or alternatively the collaboration of the chemical or the electrical industry should be sought.

The investigations were hitherto limited to chain reactions based on the action of <u>slow</u> neutrons. The neutrons emitted from the splitting uranium are fast, but they are slowed down in a mixture of uranium and a light element. Fast neutrons lose their energy in colliding with atoms of a light element in much the same way as a billard ball loses velocity in a collision with another ball. At present it is an open question whether such a chain reaction can also be made to work with <u>fast</u> neutrons which are not slowed down.

There is reason to believe that, if fast neutrons could be used, it would be easy to construct extremely dangerous bombs. The destructive power of these bombs can only be roughly estimated, but there is no doubt that it would go far beyond all military conceptions. It appears likely that such bombs would be too heavy to be transported by airplane, but still they could be transported by boat and exploded in port with disastrous results.

Although at present it is uncertain whether a fast neutron reaction can be made to work, from now on this possibility will have to be constantly kept in mind in view of its far-reaching military consequences. Experiments have been devised for settling this important point, and it is solely a question of organization to ensure that such experiments shall be actually carried out.

Should the experiments show that a chain reaction will work with fast neutrons, it would then be highly advisable to arrange among scientists for withholding publications on this subject. An attempt to arrange for withholding publications on chain reactions has already been made early in March but was abandoned in spite of favorable response in this country and in England on account of the negative attitude of certain French laboratories. The experience gained in March would make it possible to revive this attempt whenever it should be necessary.

(Leo Szilard)

October 11, 1939

Dear Mr. President:

With approaching fulfillment of your plans in connection with revision of the Neutrality Act, I trust that you may now be able to accord me the opportunity to present a communication from Dr. Albert Einstein to you and other relevant material bearing on experimental work by physicists with far-reaching significance for National Defense.

Briefly, the experimentation that has been going on for half a dozen years on atomic disintegration has culminated this year (a) in the discovery by Dr. Leo Szilard and Professor Fermi that the element, uranium, could be split by neutrons and (b) in the opening up of the probability of chain reactions, - that is, that in this nuclear process uranium itself may emit neutrons. This new development in physics holds out the following prospects:

1. The creation of a new source of energy which might be utilized for purposes of power production;

2. The liberation from such chain reaction of new radioactive elements, so that tons rather than grams of radium could be made available in the medical field;

3. The construction, as an eventual probability, of bombs of hitherto unenvisaged potency and scope: As Dr. Einstein observes, in the letter which I will leave with you, "a single bomb of this type carried by boat and exploded in a port might well destroy the whole port together with some of the surrounding territory!"

In connection, then, with the practical importance of this work - for power, healing and national defense purposes - it needs to be borne in mind that our supplies of uranium are limited and poor in quality as compared with the large sources of excellent uranium in the Belgian Congo and, next in line, Canada and former Czechoslovakia. It has come to the attention of Dr. Einstein and the rest of the group concerned with this problem that Germany has actually stopped the sale of uranium from the Czechoslovakian mines it seized. This action must be related to the fact that the son of the German Under-Secretary of State, Karl von Weizsaecker, had been an assistant at the Kaiser Wilhelm Institute in Berlin

to some of the great physicists now resident in this country who are carrying forward these experiments on uranium.

Mindful of the implications of all this for democracy and civilization in the historic struggle against the totalitarianism that has exploited the inventions of the free human spirit, Dr. Szilard, in consultation with Professor E. P. Wigner, head of the physics department of Princeton, and Professor E. Teller of George Washington University, sought to aid this work in the United States through the formation of an association for scientific collaboration, to intensify the cooperation of physicists in the democratic countries - such as Professor Joliot in Paris, Professor Lindemann of Oxford and Dr. Dirac of Cambridge - and to withhold publication of the progress in the work on chain reactions. As the international crisis developed this summer, these refugee scholars and the rest of us in consultation with them unanimously agreed that it was their duty, as well as desire, to apprise you at the earliest opportunity of their work and to enlist your cooperation.

In view of the danger of German invasion of Belgium, it becomes urgent to make arrangements - preferably through diplomatic channels - with the Union Miniere du Haut-Katanga, whose head office is at Brussels, to make available abundant supplies of uranium to the United States. In addition, it is necessary to enlarge and accelerate the experimental work, which can no longer be carried out within the limited budgets of the departments of theoretical physics in our universities. It is believed that public-spirited executives in our leading chemical and electrical companies could be persuaded to make available certain amounts of uranium oxide and quantities of graphite, and to bear the considerable expense of the newer phases of the experimentation. An alternative plan would be the enlistment of one of the foundations to supply the necessary materials and funds. For either plan and for all the purposes, it would seem advisable to adopt the suggestion of Dr. Einstein that you designate an individual and a committee to serve as a liaison between the scientists and the Executive Departments.

In the light of the foregoing, I desire to be able to convey in person, in behalf of these refugee scholars, a sense of their eagerness to serve the nation that has afforded them hospitality, and to present Dr. Einstein's letter together with a memorandum which Dr. Szilard prepared after some discussion with me and copies of some of the articles that have appeared in scientific journals. In addition, I would request in their behalf

a conference with you in order to lay down the lines of policy with respect to the Belgian source of supply and to arrange for a continuous liaison with the Administration and the Army and Navy Departments, as well as to solve the immediate problems of necessary materials and funds.

With high regard,

Yours sincerely,

The President,
The White House,
Washington, D. C.

420 West 116th Street
New York City

May 10, 1940

Dr. Alexander Sachs
c/o Lehman Corporation
One South William Street
New York City

Dear Dr. Sachs:

Our work concerning systems composed of carbon and uranium has now reached a stage at which it seems necessary to organize a large scale experiment. Only through actually carrying out such an experiment can it be demonstrated beyond doubt that a nuclear chain reaction can in fact be maintained in a system composed of carbon and uranium.

Since it appears necessary and urgent to obtain certainty in this matter we desire to start organizing a large scale experiment. This experiment would require about 100 tons of graphite and perhaps 10 to 20 tons of uranium metal. It would also require elaborate mechanisms designed to stabilize the chain reaction and to safeguard against overheating and the possibility of an explosion. Realizing that this is an enterprise which may require to its conclusion an expenditure of $ 200.000 to $ 500.000, we propose to carry out this project in successive stages. If the results obtained during the first stage are satisfactory, then the expenditure necessary for the second stage would appear to be justified, and the second stage could be started according to schedule, etc. If this procedure were adopted, then the expenditure would gradually rise parallel to the increase in our assurance of the smooth functioning and final success of the large scale experiment.

In the first stage we would propose to carry out a general survey of all nuclear constants involved with a view to confirming the values previously obtained and to narrowing down the limits of experimental error of the observed values of these constants. A successful conclusion of this survey would strengthen our assurance of the ultimate success of the experiment and would enable us to find the optimum conditions for its performance. Concurrently with this survey, certain other work would have to be done in order to prepare the ground for the experiment. Such work would include the designing of constructional details, the carrying out of technological tests on samples of materials which have to be

November 5th, 1939

Dr. Alexander Sachs
One Sotth William Street
New York City

Dear Dr. Sachs:

I wish to confirm our appointment for Tuesday night, 7 p.m., at the Men's Faculty Club of Columbia, 400 West 117th Street (117th Street and Morningside Drive). I think you will find both Dr. Pegram and Dr. Fermi very enjoyable persons.

In addition to what I told you over the telephone I should like to make some observations for your personal information:

I expected Briggs to enlarge his committee by including men like you, K.T. Compton or G.B. Pegram. It was a surprise for me to hear that he wanted to include also a group of younger physicists who are themselves actively engaged in doing research on uranium, namely Fermi, Tuve and Beams.

To the inclusion of this second group I should like to make two observations:

1. Since it so happens that the proposed second group includes the name of Fermi we could be assured that the committee will always be well informed and conscientiously advised. The committee would not have to depend on information gathered

haphazardously. This may prove to be a very important point and may outweigh all other considerations.

2. The fact that such a second group is being included and that it does not contain my name will make it virtually impossible for me to do in the future what I tried to do in the past, i.e. concern myself beyond the scope of my own experiments with the broader aspects connected with the possibility of a chain reaction, and to act as a driving power in this connection. For me to go on in the future as I did in the past, with a status wholly undefined at a time when some other colleagues have a clearly defined status, would hardly be advisable and in the end probably physically impossible.

I came up against similar difficulties in England six years ago. When the German government started to dismiss German scholars I persuaded Sir William Beveredge to form a committee and create an organization for assisting and placing these scholars. After this was done I went on working for this cause for another six months without having any defined status. Though I finally succeeded in getting a number of things done by exerting myself up to the limit of my strength I learned a lesson, and now I am anxious to avoid a repetition of this experience.

This point may have little importance from a general point of view, but I feel that I have to state my case now so that after the proposed committee has been appointed you may not think that I am willfully abandoning a cause when in fact I shall have little choice left in the matter.

In addition to these observations I should like to repeat what I told you over the telephone:

It seemed to me that the omission of the name of G.B. Pegram, who is Head of the Physics Department at Columbia and also Dean of the Graduate School, might be an objective mistake and at the same time also be embarrassing to Fermi. I had a conversation on this subject with Fermi, and we thought that if the committee had the right to co-opt members you might find it perhaps possible to suggest the inclusion of Pegram at the first meeting of the committee.

On Monday I shall telephone your secretary in order to find out if there are any points in the memorandum which you are preparing, or anything else, which you care to discuss with me. I am looking forward to seeing you in any case Tuesday night.

Yours very sincerely,

(Leo Szilard)

Hotel King's Crown
420 West 116th Street
New York City

November 8th, 1939

Dr. Alexander Sachs
One South William Street
New York City

Dear Dr. Sachs:

Dr. Fermi and I discussed the question which you have raised. It seems to us that it will be useful to have a small group of physicists, whose residence is not too far from Washington, D.C., consult with each other at regular intervals on questions connected with research on uranium. We attempted to draw up a list of names for this purpose. In our opinion such a list ought to include the following names to which others might be added, if required.

Beams - Charlottesville, Va.
Fermi - New York
Furry - Cambridge, Mass.
Szilard - New York
Teller - Washington,D.C.
Tuve - Washington, D.C.
Wheeler - Princeton.

In drawing up this list we kept in mind two points:

a) the question of residence of the man selected. The geographical boundary line was drawn at the distance Washington to Boston;

b) the advisability of having a number of the more important eastern universities represented, at which research on uranium has been carried on in the past or might be started in the near future.

Furthermore it seems to us that it might be useful to ask certain small groups of workers to consider themselves responsible for clearing up a given aspect of the question and to submit a report within six months' or a year's time. It would be the task of these groups to see to it that the questions involved are vigorously pursued, either by some members of the group or by others. Such a group would be expected to report at once if they encounter difficulties which they are unable to overcome, so that the help of others can be enlisted.

In our opinion the following persons might be asked to report on, and concern themselves with:

1. Slow Neutron Reaction:

   Fermi, Pegram, Szilard, Wheeler.

2. Fast Neutron Reaction:

   Fermi, Szilard, Tuve, Wigner.

3. The Question which of the Uranium Isotopes splits:

   Dunning, Fermi, Tuve, Wheeler.

4. Small Scale Separation of Isotopes by any Method except Diffusion:

   Beams, Fermi, Tuve.

5. Small Scale Separation of Isotopes by Diffusion:

   Fermi, Furry, Urey.

6. Theoretical Possibility and Limitation of Large Scale Separation by Centrifuging:

   Beams, Pegram, Szilard, Teller.

7. Theoretical Possibility and Limitation of Large Scale Separation by Diffusion:

   Fermi, Furry, Onsager, Urey.

8. Possibility of Large Scale Production of Uranium Metal:

   Pegram, Szilard, and somebody from the Department for Chemical Engineering of MIT or Columbia.

These groups include the following names:

Beams - University of Virginia,
Fermi - Columbia,
Furry - Harvard,
Dunning - Columbia,
Pegram - Columbia,
Onsager - Yale,
Szilard - Columbia,
Teller - George Washington University,
Tuve - Carnegie Institute of Terrestrial Magnetism,
Urey - Columbia,
Wheeler - Princeton,
Wigner - Princeton.

We could not discuss the tentative proposals contained in this letter with Professor Pegram on account of his absence, and the time was too short to discuss it with anybody else.

Yours very sincerely

(Leo Szilard)

Alexander Sachs

October 17, 1939

Dear Professor Wigner:

In keeping with our conversation on your recent visit to my office and in furtherance of later developments reported to you by Dr. Szilard, I had a conference in Washington on October 11th with a committee appointed by the President, headed by General Watson, his executive secretary and military aide. After that conference I had the honor to present the matter to the President and to leave with him a dossier consisting of Dr. Einstein's letter, Dr. Szilard's memorandum, and my own original letter-memorandum on the subject addressed to him.

On the following day the President appointed a small committee representing the Army, the Navy and the Bureau of Standards, in the persons of Colonel Adamson, Commander Hoover and Dr. Lyman Briggs. Dr. Briggs then, in consultation with me, arranged and formally issued an invitation on the following day for a conference to be held this week at Washington with your goodself and Dr. Szilard, as the scientific complement, and myself as the intermediary, and the informal committee above mentioned. To suit your joint preferences, as conveyed to me by Dr. Szilard, the date was shifted from Wednesday to Saturday morning, October 21st, at 9:30 at the office of the Bureau of Standards in the U. S. Department of Commerce. This afternoon Dr. Briggs warmly approved the suggestion of Dr. Szilard regarding the inclusion of Professor E. Teller of George Washington University and indicated that he would add two scientists conversant with this subject. Such, then, is the diary of the events since our last talk.

Will you be good enough to confirm to me your acceptance and will you also indicate whether you would wish to have a conference prior to our departure, or, alternatively, that we meet Friday night on the 12:50 train from Pennsylvania Station to Washington. In either event, I should like to have you and Dr. Szilard as my guests at breakfast at the Carlton Hotel Saturday morning, and we would thereafter proceed to the Department of Commerce building for our appointment.

Yours sincerely,

Professor E. P. Wigner,
Fine Hall,
Princeton University,
Princeton, N. J.

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October 17, 1939

Dear Professor Wigner:

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Yours sincerely,

Alexander Sachs

Professor E. P. Wigner
Fine Hall
Princeton University,
Princeton, N. J.

C
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[Sachs] → Feller

October 17, 1939

My dear Professor Teller:

In the wake of numerous conferences with Dr. Szilard since late summer and a more recent meeting with Professor Wigner of Princeton, I had the honor to submit last week to the President and to an informal committee from the Army, the Navy and the Bureau of Standards called together at his instance, information regarding the experimental work conducted by Dr. Szilard, Professor Fermi and others on atomic disintegration and certain proposals for aiding that work in the light of its potential significance for national defense.

Following that conference there was formed a committee including Colonel Adamson, Commander Hoover and Dr. Lyman J. Briggs. A conference has been scheduled by this committee with Professor Wigner, Dr. Szilard and myself for Saturday morning, October 21st, at 9:30 in Dr. Briggs' office in the Bureau of Standards at the Department of Commerce. In a telephone conversation with Dr. Briggs this afternoon, I submitted to him a suggestion which he cordially accepted, namely that you be included in this conference as one of the cognoscenti of this subject and as a common friend of the scientists from this end and the scientists from the Government end.

While I take it that you will hear direct from Dr. Briggs, this letter and the supplementary memorandum of Dr. Szilard will, I trust, serve to reinforce the invitation and to provide orientation on the purpose of the conference. As a matter of convenience, would you be good enough to call for us at the Carlton Hotel at 9:15 Saturday morning, when we will be arranging to proceed to the Department of Commerce.

Yours sincerely,

Professor E. Teller,
George Washington University,
Washington, D. C.

Mrs Charlotte Locke, 1200 Fifth Ave,
(Alexander) N.Y. 10029

From Einstein file

dft.f.letter to A.Sachs with corrections by L.Szilard

[March 7,1940]

Draft.

From L. Szilard
Un. 4-2700

Dr. Alexander Sachs
c/o Lehman Corporation
One South William Street
New York City

420 W 116
Ky

Dear Dr. Sachs:

I understand that you are familiar with the situation which has arisen in connection with the study of uranium, and that, thanks to your disinterested intervention ~~in Washington in October last year~~, some support will now be forthcoming for certain important experiments on uranium.

Last year, when I realized that results of national importance might arise out of this research, I thought it my duty to draw the attention of the administration to this possibility. You will perhaps remember that in the letter which I addressed to the President I also mentioned the fact that C.V. von Weizsaecker, son of the German Secretary of State von Weizsaecker, was collaborating with a group of chemists working on uranium at one of the Kaiser Wilhelm Institutes, namely the Institute of Chemistry. Since the outbreak of the war interest in the possible applications of uranium has greatly increased, I have now learned that this research is being carried out in great secrecy and that it has been extended to another of the Kaiser Wilhelm Institutes, the Institute of Physics.

~~The former director was sent away on a leave of absence, apparently for the duration of the war.~~ The latter ~~The Institute~~ has been taken over by the government, and a group of physicists is now working there on uranium under the leadership of C.F. von Weizsaecker in collaboration with the Institute of Chemistry.

Should you think it advisable to relay this information to the ~~administration in~~ Washington, please consider yourself free to do so. ~~In that case,~~ would you perhaps be kind enough to let me know ~~when you have the acknowledgement of receipt by the government.~~ whether you are taking any action in this connection. 2

Dr. Szilard has shown me the manuscripts of two papers which he has sent to the Physical Review, in which he describes in detail a method for setting up a chain reaction in uranium. These papers will appear in print unless they are held up, and the question arises whether something ought to be done to ~~prevent~~ withhold publication. The answer to this question depends ~~entirely~~ on the general policy which is being adopted by the Administration, with respect to Uranium

I have discussed with Dr. Wigner of Princeton University and Dr. Szilard the situation in the light of the information which is now available. Dr. Szilard will let you have a short memorandum informing you of the progress he has made since October last year, so that you might be able to take such action as you think advisable in the circumstances. You will see that the line which he pursued is different from the line pursued by Mr. Joliot in France, about whose work you may have seen reports in the papers.

James Franck

From Einstein
Archive

March 7, 1940

Dr. Alexander Sachs
c.o Lehman Corporation
One South William Street
New York City

Dear Dr. Sachs:

In view of our common concern in the bearings of certain experimental work on problems connected with national defense, I wish to draw your attention to the development which has taken place since the conference that was arranged through your good offices in October last year between scientists engaged in this work and governmental representatives.

Last year, when I realized that results of national importance might arise out of the research on uranium, I thought it my duty to inform the Administration of this possibility. You will perhaps remember that in the letter which I addressed to the President I also mentioned the fact that C.F. von Weizsaecker, son of the German Secretary of State von Weizsaecker, was collaborating with a group of chemists working on uranium at one of the Kaiser Wilhelm Institutes, namely the Institute of Chemistry.

Since the outbreak of the war interest in uranium

has intensified in Germany. I have now learned that research there is being carried out in great secrecy, and that it has been extended to another of the Kaiser Wilhelm Institutes, the Institute of Physics. The latter has been taken over by the government, and a group of physicists under the leadership of C.F. von Weizsaecker is now working there on uranium in collaboration with the Institute of Chemistry. The former director was sent away on a leave of absence, apparently for the duration of the war.

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I have discussed with Dr. Wigner of Princeton University and Dr. Szilard the situation in the light

of the information which is now available. Dr. Szilard will let you have a memorandum informing you of the progress made since October last year, so that you may be able to take such action as you think in the circumstances advisable. You will see that the line which he has pursued is different from and apparently more promising than the line pursued by M. Joliot in France, about whose work you may have seen reports in the papers.

Yours sincerely,

A. E.

Memorandum attached to the letter addressed to Dr. Alexander Sachs

dated March the 13th, 1940

The possibility of two different types of chain reactions at present is under investigation, i.e.:

a. A chain reaction in a system composed of uranium and carbon in which the active agent is the rare isotope contained in uranium.

b. A chain reaction in a system composed of uranium metal in which the active agent would be the bulk of the uranium itself.

~~Our~~ Research is much more advanced on the first of these two subjects than on the second and a positive result can be expected with great assurance in the first case. However, a positive result in the second case would have even more far-reaching consequences than in the case of a system composed of uranium and carbon, and therefore research along this line ought to be pressed, also.

Part I

If a chain reaction can be maintained in a system composed of carbon and uranium such a system will be capable of applications which have a bearing on questions of national defense.

1. Such a system may be used as a weapon in the following manner: a chain reaction may be maintained in this system and the neutrons emanating from the chain reaction may be allowed to escape. The intensity of the neutron radiation could be made so high that this radiation would fatally injure by its physiological action human beings who are exposed to it within a radius of one kilometer. By mentioning this fact it is not desired to imply that such a system represents a desirable or particularly efficient military weapon. The reason for emphasizing this point lies rather in the belief that such a system could be used as a weapon by some other country (possibly in the near future) ~~possibly~~ during the present war and that ~~this weapon may~~ it could be used with considerable effect on a country which is not prepared to meet this new type of attack.

2. A system composed of carbon and uranium might be used for purposes of power production. Questions relating to the transformation into power of the energy liberated in the chain reaction

have been studied as well as questions relating to the regulation of the chain reaction, and methods for avoiding accidental overheating have been devised. Personnel has to be protected from being exposed to the radiations emanating from the chain reaction by means of water tanks and equipped in this way such an atomic engine could be used as a power reserve in larger naval units. The weight of the water tank rules out the possibility of using an atomic engine for the purpose of driving aeroplanes.

One ton of uranium would be capable of supplying about as much power as three thousand tons of oil.

For instance: a 30,000 ton battleship which would be equipped for the use of both oil fuel and atomic power, may have a maximum oil load of 4000 tons, but would have in 50 tons of uranium the equivalent of an oil reserve of about 150,000 tons leading to practically unlimited cruising radius.

Since a battleship equipped with an atomic engine need not carry in war-time more than a normal oil load of perhaps one thousand tons there would result a saving in weight even if allowance is made for the weight of the atomic engine. This saving in weight would lead to an increase in top speed.

The limited supply of uranium would make it inadvisable to use up any considerable amounts for naval purposes in peace time and the atomic engine with which battleships may be equipped must not be used except occasionally in maneuvers and in case of actual warfare. Since a large battleship or battlecruiser will use more than one-half a ton of oil per mile if cruising at an economical speed, it would exhaust its full oil load of about four thousand tons during the cruise covering about ten thousand miles. This means that such a ship can not operate for any length of time at a distance of about four to five thousand miles from its nearest base. The advantage of a battleship having an equivalent of an oil reserve of one hundred fifty thousand tons would in these circumstances be decisive since apart from the increased speed it could stay for a long period near its objective at any distance from its base.

in this way such an atomic engine could be used as a power reserve in larger naval units. The weight of the water tank rules out the possibility of using an atomic engine for the purpose of driving aeroplanes.

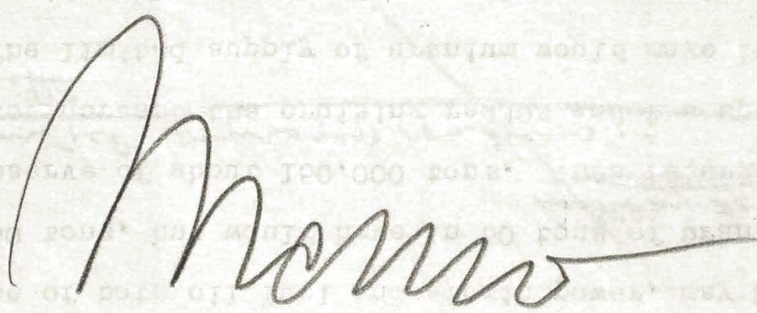
One ton of uranium would be capable of supplying about as much power as three thousand tons of oil. ~~For instance:~~

For instance: a 30,000 ton battleship which would be equipped for the use of both oil fuel and atomic power, may have a maximum oil load of 4000 tons, but would have in 50 tons of uranium the equivalent of an oil reserve of about 150,000 tons. ~~This reserve could be used in war-time to increase the cruising radius and the speed.~~

The limited supply of uranium would make it inadvisable to use up any considerable amounts for naval purposes in peace time and the atomic engine with which battleships may be equipped ~~should~~ not be used except occasionally in maneuversand in case of actual warfare. Since a large battleship or battle cruiser will use more than one-half a ton of oil per mile if cruising at an economical speed, it would exhaust its full oil load of about four thousand tons during the cruise covering about ten thousand miles. This means that such a ship can not operate for any length of time at a distance of about four to five thousand miles from its nearest base. The advantage of a battleship having an equivalent of an oil reserve of one hundred fifty thousand tons would in these circumstances be decisive since apart from the increased speed ~~which would enable such a boat to out run all other boats it could stay for a long period near its objective at any distance from its base.~~

Uranium occurs in the United States chiefly in the form of carnotites which is an ore poor in uranium and which is at present solely ~~in mind~~ for the sake of its vanadium content. The total deposit is estimated to contain three thousand tons of uranium oxide. In view of the fact that this ore is at present not worked up for uranium it may be essential to secure a supply of uranium from abroad. Three hundred tons could perhaps be thus obtained per year and diverted for purposes of the navy.

Whether or not it will be possible for the Unites States Government to secure such an adequate supply of uranium will ~~obviously~~ depend upon whether or not the Government of the United States knows ahead of other



governments with a fair degree of certainty that uranium can in fact be used for such purposes as are outlined above.

A number of atomic constants have to be measured and older measurements to be repeated before we can answer with certainty this question and before we can make an experiment on a large scale for purposes of demonstration. A number of experiments have been devised for the purpose of measuring those constants which could be carried out speedily and which would involve an expenditure not exceeding $100,000.

At present this work is ~~strongly hampered by a total~~ lack of funds which has slowed down this work during the last twelve months. The group working along this line of research consists at present of Professor Fermi who is a member of the Physics Department and has many duties other than carrying out work on uranium; a graduate student who, apart from working on his thesis is burdened with teaching duties; and myself.

An important experiment on the properties of graphite had been devised and put forward in July last year and which could have been carried out within three months given modest facilities and proper organization, is now being supported by the Government through the loan of material but otherwise is still hampered from lack of facilities other than material. It will now be carried out in a preliminary form in the next few weeks but it is doubtful whether it can be completed in the proper form under the present working conditions before October. While this experiment will give valuable information it can not be expected to answer the pertinent question with certainty. A number of other experiments are to be carried out simultaneously before we can state with sufficient certainty that a chain reaction can be maintained under conditions which are of interest from the point of view of the above-mentioned naval application. It appears doubtful that if the work is carried on within the present frame-work and with the limited funds now available the desired conclusion can be reached in time to enable the Government to secure an adequate supply of uranium from abroad. In contrast to this, information in our possession shows that work on uranium is carried out in Germany in a large scale and in great secrecy. All physicists who ~~were supposed~~ are believed to be capable of work on this subject have been gathered in one of the Kaiser Wilhelm institutes in Berlin which has been taken over by

the government for this purpose. One might attempt to guess along what lines this research in uranium is being conducted in Germany from the special field of work of the scientists whose names are in part in my possession but otherwise I have no information on this point. It may be that the chief interest is centered around the possibility of having naval raiders equipped with an atomic engine but there is reason to believe that the work which is being pursued in Germany is not limited to this comparatively harmless objective.

L. Szilard
420 West 116 Street
New York City
May 12, 1940

Dr. Alexander Sachs
c/o Lehman Corporation
1 South Williams Street
New York City

Dear Dr. Sachs:

Our work concerning systems composed of carbon and uranium has now reached a stage at which it seems necessary to organize a large scale experiment. Only through actually carrying out such an experiment can it be demonstrated beyond doubt that a musclear chain reaction can in fact be maintained in a system composed of carbon and uranium.

All nuclear constants involved have now been measured and the best experimental values obtained for these constants lead to the conclusion that such an experiment may be expected to be successful. It must be emphasized, however, that a number of the nuclear constants which are involved is large and that the value of each of these constants is known only within certain, occasionally fairly wide, limits set by the experimental error. In the circumstances a forecast based on the values obtained by small-scale laboratory experiments can at best be made with a fair degree of assurance but not with absolute certainty.

Since it appears necessary and urgent to obtain certainty in this matter we desire to start organizing a large scale experiment. This experiment would require about 100 tons of graphite and perhaps 10 to 20 tons of uranium metal. It would

also require elaborate mechanisms designed to stabilize the chain reaction and to safe-guard against over-heating and the possibility of an explosion. Realizing that this is an enterprise which may require to its conclusion an expenditure of $200,000 to $500,000 we propose to carry out this project ~~by stages~~ step by step. If the results obtained during the first stage are satisfactory, then the expenditure necessary for the second stage would appear to be justified and the second stage could be started according to schedule, etc. If this procedure were adopted, then the expenditure would gradually rise parallel to the increase in our assurance of the smooth-functioning and final success of the large scale experiment.

In the first stage we would desire to carry out a general survey of all nuclear constants involved with a view to confirming the values previously obtained and to narrowing down the limits of experimental error of the observed values of these constants. A successful conclusion of this survey would strengthen our assurance of ultimate success in the experiment and would enable us to find the optimum conditions for the large scale experiment. Concurrently, with this survey, certain other work would have to be done in order to prepare the ground for the large scale experiment. Such work would include the working out of constructional details in the form of drawings, the carrying out of technological tests on samples of material which will be used in large quantities in the ultimate experiment, and ~~negotiating~~ obtaining for bids for the

manufacture of such material in the required quality and quantity. An expenditure of $50,000 would probably be sufficient to bring this first stage in the organization of the large scale experiment to its conclusion and would bring us up to the next stage. During the second stage of the work the expenditure would gradually rise and may reach a total of $500,000 by the time the large scale experiment is concluded.

If a fund were set up under the direction of a board of trustees who had the confidence of the government, as set forth in the letter of professor Einstein, ~~which was~~ read by Dr. Briggs at the meeting ~~held~~ on April 27th in the Bureau of Standards, ~~Professor~~ Dr. Fermi and I would be glad to accept the responsibility for carrying out the large scale experiment under the direction of such a board and would be pleased to have our work supervised by a small committee of scientists who might be entrusted by the board with the task of advising the board.

It is my personal opinion that Dr. Fermi, myself and the proposed small committee of scientists should be left a free hand to spend up to 25% of the expenditure for studying the possibility of a fast neutron reaction. It is further a personal opinion that, if the study of the separation of the uranium isotopes ~~is~~ were to be included in the program of work, then Dr. Urey of Columbia and Dr. Beams of the University of Virginia ought to be asked to accept responsibility for the direc-

420 West 116th Street
New York City

March 13th, 1940

Dr. Alexander Sachs
c/o Lehman Corporation
One South William Street
New York City

Dear Dr. Sachs:

I wish to inform you of the development which has taken place since the meeting in Washington which both of us attended in October last year.

Work by Joliot and his group in France, which has become known, was conducted on mixtures of uranium and water. It leaves the question undecided whether a divergent chain reaction can be maintained in such mixtures, but otherwise furnishes much useful information. It may be pointed out that, even if it should be possible to maintain a chain reaction in mixtures of water and uranium, the rate of reaction would necessarily be limited by the fact that, if water is used, the temperatures must not be allowed to rise much above 100 C, since otherwise the high vapor pressure of water will burst the vessel containing the mixture.

Work in Germany is being carried out in secret, and no information is available as to what experiments have been performed.

I have devised a method which should make it possible to maintain a chain reaction in a system composed of uranium and carbon, worked out means for stabilizing the chain

reaction so as to avoid accidental overheating, and studied questions relating to the transformation into power of the energy liberated in the chain reaction. Details of this method are described in an unpublished paper which I have submitted to the Physical Review.

This work has now reached a point at which a large scale experiment using about 10 to 20 tons of uranium and 50 to 100 tons of graphite ought to be prepared. This large scale experiment may involve a cost of perhaps $ 200 000, ~~and~~ before actually embarking on it, it would appear reasonable to re-measure all physical magnitudes which enter into the calculation.

While I have been using the best values available and so arrived at the conclusion that we may expect this large scale experiment to be successful, some of the values which I used may perhaps be in error. A general check-up of all values would therefore appear to be a wise precaution, which I feel inclined to advocate. Moreover, if we had more accurate values, we would be able to calculate more precisely the most favorable conditions under which the large scale experiment ought to be set up. I estimate that a fund of $ 50 000 ought to be established for preparing this large scale experiment, and such a fund would also provide for certain preliminary technological tests which, in my opinion, should be carried out before orders for the large scale experiment are finally placed.

The possibility of obtaining large quantities of radioactive elements for medical purposes would in itself justify these expenditures. Other aspects of possible applications are discussed in a memorandum which you will find enclosed.

Yours sincerely,

Leo Szilard

(Leo Szilard)

Memorandum attached to the letter addressed to Dr. Alexander Sachs, dated March 13, 1940.

Part I.

A chain reaction maintained in a system composed of carbon and uranium would be capable of applications which have a bearing on questions of national defense.

1. Such a system may be used as a weapon in the following manner: a chain reaction may be maintained in this system, and the neutrons emanating from the chain reaction may be allowed to escape. The intensity of the neutron radiation ~~can~~ could be made so high that this radiation would fatally injure by its physiological action human beings who are exposed to it within a radius of one kilometer. This new weapon could be worked out in a short time and put to practical use. It is not suggested as a desirable or efficient military weapon, but attention is drawn to the point that the use of this weapon may have considerable effect on an enemy who is unprepared to defend himself against it.

2. A system composed of carbon and uranium might be used for purposes of power production. Questions relating to the transformation into power of the energy liberated in the chain reaction have been studied as well as questions relating to the regulation of the chain reaction, and methods for avoiding accidental overheating have been devised.

This type of power source may be used for supplying a reserve of driving power in naval vessels. One ton of uranium would be capable of supplying about as much power as 3000 tons of oil. After this amount of power has been produced, so much

of the active agent contained in the uranium will have been used up that the remaining uranium will probably be of no further value for power production.

For instance, a 30 000 ton battleship which would be equipped for the use of both oil fuel and atomic power, may have a maximum oil load of 4000 tons, but would have in 50 tons of uranium the equivalent of an oil reserve of about 150 000 tons. This reserve could be used in war time to increase the cruising radius and the speed.

The scope of this application is limited by the limited supply of uranium, but it may perhaps be possible to divert 300 tons of uranium per year for the purposes of the Navy.

Since human beings will have to be protected by large water tanks from being exposed to neutron radiations emanating from the chain reaction, the weight of this type of equipment will be considerable. For this reason, atomic power is not suitable for small naval units and cannot be used for the purpose of driving airplanes.

Part II.

Whereas we may expect a chain reaction to take place in a system composed of uranium and carbon, it is not known whether a chain reaction could be maintained in pure uranium metal in which the more abundant isotope of uranium would represent the active agent.

1. If such a chain reaction ~~could~~ can be maintained in pure uranium metal, it would be possible to bring about explosions in large masses of this metal, which would cause destruction comparable only to that of an earthquake.

2. If such a chain reaction ~~could~~ can be maintained in a mass of pure uranium metal, it could be used as a source of power, for instance for driving naval vessels, as discussed in part I, but in this case one ton of uranium would supply as much power as 400 000 tons of oil. The present naval building program might then appear rather obsolete.

420 West 116th Street
New York City

March 13th, 1940

Dr. Alexander Sachs
c/o Lehman Corporation
One South William Street
New York City

Dear Dr. Sachs:

I wish to inform you of the development which has taken place since the meeting in Washington which both of us attended in October last year.

Work by Joliot and his group in France, which has become known, was conducted on mixtures of uranium and water. It leaves the question undecided whether a divergent chain reaction can be maintained in such mixtures, but otherwise furnishes much useful information. It may be pointed out that, even if it should be possible to maintain a chain reaction in mixtures of water and uranium, the rate of reaction would necessarily be limited by the fact that, if water is used, the temperatures must not be allowed to rise much above 100 C, since otherwise the high vapor pressure of water will burst the vessel containing the mixture.

Work in Germany is being carried out in secret, and no information is available as to what experiments have been performed.

I have devised a method which should make it possible to maintain a chain reaction in a system composed of uranium and carbon, worked out means for stabilizing the chain

reaction so as to avoid accidental overheating, and studied questions relating to the transformation into power of the energy liberated in the chain reaction. Details of this method are described in an unpublished paper which I have submitted to the Physical Review.

This work has now reached a point at which a large scale experiment using about 10 to 20 tons of uranium and 50 to 100 tons of graphite ought to be prepared. This large scale experiment may involve a cost of perhaps $ 200 000, and before actually embarking on it, it would appear reasonable to re-measure all physical magnitudes which enter into the calculation.

While I have been using the best values available and so arrived at the conclusion that we may expect this large scale experiment to be successful, some of the values which I used may perhaps be in error. A general check-up of all values would therefore appear to be a wise precaution, which I feel inclined to advocate. Moreover, if we had more accurate values, we would be able to calculate more precisely the most favorable conditions under which the large scale experiment ought to be set up. I estimate that a fund of $ 50 000 ought to be established for preparing this large scale experiment, and such a fund would also provide for certain preliminary technological tests which, in my opinion, should be carried out before orders for the large scale experiment are finally placed.

The possibility of obtaining large quantities of radioactive elements for medical purposes would in itself justify these expenditures. Other aspects of possible applications are discussed in a memorandum which you will find enclosed.

Yours sincerely,

(Leo Szilard)


[Sachs] → FDR

March
~~October~~ 15, 1940

Dear Mr. President:

As a sequel to the communication which I had the honor to submit to you on October 12, Professor Albert Einstein sent me another regarding the latest developments touching on the significance of research on uranium for problems of national defense. In that letter he suggests that I convey to you the information that has reached him that since the outbreak of the war, research with uranium is being carried out in great secrecy at the Berlin Institute of Physics, which has been taken over by the Government and placed under the leadership of C. F. von Weizsaecker, son of the German Secretary of State.

In the realization that these further views of Dr. Einstein have a definite bearing on the favorable report submitted to you by Dr. Briggs as Chairman of the Committee which conferred with experimental scientists concerned and myself, I am enclosing his communication for your kind perusal. May I also ask whether and when it would be convenient for you to confer on certain practical issues brought to a focus by the very progress of the experimental work, as indicated in the concluding paragraph of Dr. Einstein's letter.

In view of your original designation of General Watson in this matter, I am transmitting it through his good offices.

Yours sincerely,

The President
The White House
Washington, D. C.

11

PL

April 1, 1940

Dear Dr. Sachs:

I regret not having known that you have recently communicated xxxx on the subject of uranium research with the White House and that Dr. Briggs and Colonel Adamson concerned themselves with this question. Otherwise, I would have informed Dr. Briggs of the development that has taken place since last year and would have sent him a copy of the detailed paper which is as yet unpublished and possibly may remain so. I understand that Dr. Briggs and Colonel Adamson thought that further action could wait until the experiments which are at present being jointly conducted by Professor Fermi and myself on the properties of graphite have been concluded. To this point I wish to make the following comment: the experiment on graphite is part of a line of research which if successful will in my opinion provide battleships and battle cruisers with a reserve driving power equivalent to 150,000 tons of xxx oil for every 50 tons of uranium. This will perhaps mean that the present battleships will have to be considered as obsolete. Whether it will be possible to secure for the United States a sufficient supply of uranium will depend upon whether the Government of the United States knows ahead of other governments with a fair degree of certainty that uranium can in fact be used for such purposes. I can not imagine if this is properly explained that anybody would take the responsibility for delaying such action as is now possible which does not involve any expenditure beyond perhaps $50,000 to xx $100,000. We have ~~very~~ reliable information to the effect that a number of important physicists have been gathered in Berlin for the purpose of working on uranium and this is in striking contrast to the way in which all work is at present organized. The present experiment on graphite for instance in which we are engaged will hardly be finished before July. Given ~~modest means~~ a fund not exceeding $6000 and proper organization it could have been carried out within three months after it had been put forward in July last year. This experiment, however xx important will hardly answer the pertinent question with the necessary certainty. A number of other experiments will have to be performed and some of the old

SUMMARY

It isshown that a

Memorandum attached to the letter addressed to Dr. Alexander Sachs, dated March the 13th, 1940.

~~Part I.~~

The possibility of two different types of chain reactions is at present under investigation, i.e.:

a. A chain reaction in a system composed of uranium and carbon in which the active agent is the rare isotope contained in uranium and b. a chain reaction in a system composed of uranium metal in which the active agent would be the bulk of the uranium itself.

Our research is much more advanced on the first of these two subjects than on the second and ~~also, ultimate success is more probable;~~ and a positive result can be expected with great assurance in the first case ~~than in the second.~~

Part I.

A chain reaction maintained in a system composed of carbon and uranium would be capable of applications which have a bearing on questions of national defense.

1. Such a system may be used as a weapon in the following manner: a chain reaction may be maintained in this system and the neutrons emanating from the chain reaction may be allowed to escape. The intensity of the neutron radiation could be made so high that this radiation would fatally injure by its physiological action human beings who are exposed to it within a radius of one kilometer. ~~This~~ new weapon could be worked out in a short time and put to practical use. It is not suggested as a desirable or efficient military weapon, but attention is drawn to the point that the use of this weapon may have considerable effect on an enemy who is unprepared to defend himself ~~against it~~.

2. A system composed of carbon and uranium might be used for purposes of power production. Questions relating to the transformation into power of the energy liberated in the chain reaction have been studied as well as questions relating to the regulation of the chain reaction, and methods for avoiding accidental overheating have been devised.

Personnel ~~could~~ be protected from being exposed to the radiations emanating from the chain reaction by means of water tanks and equipped

experiments repeated before we can state with sufficient certainty that a chain reaction will go on in circumstances which are of interest for the above-mentioned naval purposes. I very much doubt that if we go on with our work with the present frame-work and using the funds of the Physics Department at Columbia we shall be able to reach the final conclusion in time to enable the Government to secure an adequate supply of uranium from abroad. ~~In my personal opinion, it would~~ might then be even better to join some industrial organization and carry out the work within ~~such a frame-work~~. If the situation can not be remedied then the question arises if it would not be better from the point of view of national defense as well as from my personal point of view to try to interest some industrial organization and get them to carry out this development pushed by the expectancy of profit, as fast as they can and inform the Government of the result obtained in the hope of Government orders.

In my opinion the best way of helping in our work would be the setting up of a fund of $50,000 to $100,000 to be used for experiments which have been devised by Fermi or myself and which could be carried out at Columbia or at some other university.

Alternatively, since in 1935 I assigned a secret British patent to the British Navy on the subject of nuclear chain reactions I might attempt to enlist the support of the British Government for these experiments and reserve the right to also inform the United States Government of the result.

SUMMARY

It isshown that a

Remarks to the above.

According to information which is now available, work on uranium is being carried out in Germany in secrecy and on a large scale, but it is not known along what line this work is proceeding.

Germany is perhaps interested in the chain reaction as a source of power for naval purposes, as discussed in point 1., because it would enable her to build fast naval raiders which could operate without a fuel supply. Since, however, a large number of details have to be worked out in order to adapt the chain reaction as a source of power to naval purposes, it should take considerable time before this method can be put to practical use.

If work in Germany is proceeding along a line aimed at producing a neutron radiation for military purposes, as discussed in point 2., then it may very well lead to a new weapon in a short time.

Work on a chain reaction in pure uranium metal, as discussed in point 3., is likely to proceed more slowly and is less promising of success, but since it would lead to a very powerful explosive, it may be that this line of work is of more interest to Germany than the others which were mentioned.

420 West 116th Street
New York City

April 14, 1940

Dr. Alexander Sachs
c/o Lehman Corp.
One South William Street
New York City

Dear Dr. Sachs:

If the line of work, which I am pursuing at present, is successful, then one ton of uranium would be capable of supplying as much power as 3000 tons of oil. The scope of applications would be rather limited, but an important application might be the use of an atomic engine as a reserve driving power for larger naval units. Let me illustrate this by quoting an example:

A 30 000 ton battleship of the fastest type has nowadays a maximum oil load of about 4000 tons and uses somewhat more than ½ ton of oil per mile if cruising at an economical speed. This corresponds to a cruising radius of about 8000 miles. Let us now consider such a battleship equipped with an atomic engine ~~containing~~ adapted to consume ~~50 tons of uranium as~~ a reserve driving power ~~and~~ in assume that the ship would also carry a normal oil load of 1000 tons. The 50 tons of uranium represent the equivalent of an oil reserve of about 150 000 tons of oil and so remove the limitations which arise out of the present finite cruising radius. The equipment which goes with the atomic engine may add about 1000 tons to the weight of the boat, but this would be more than compensated by the saving in weight owing to the reduction of the oil load from 4000 tons to 1000 tons. This saving in weight

ought to lead to an increase in the top speed of the vessel.

I should imagine that the combination of high speed and a greatly increased cruising radius might be of decisive importance in case of a war with Japan. However, my knowledge of such matters is not sufficient for doing more than raising this question and leaving it to you to find the answer by consulting some expert.

It might be difficult to obtain more than 300 tons of uranium per year for the purposes of the navy. This amount would be sufficient to equip six capital ships annually. These ships would presumably continue to use oil in peace time, except perhaps at manoeuvres, so as to have most of their uranium reserve available at the outbreak of war.

Perhaps I should mention another line of research which might lead to the construction of an atomic engine in which one ton of uranium would supply more power than 300 000 tons of oil. Experiments along this line of work are however not sufficiently advanced to enable us to estimate the chances of ultimate success. This second type of atomic engine would however be of much greater importance to the navy than the one which is the main subject of my letter.

Yours sincerely,

Leo Szilard

(Leo Szilard)

Professor Lyman J. Briggs

[Sachs?] to Einstein

April 15, 1940

Dear Dr. Einstein:

In connection with your important communication of March 7th in regard to the research in uranium and its bearing on national defense, I wrote to the President on March 15th, as per enclosed copy, and have at first received an acknowledgment from his secretary, General Watson. It would appear that upon his return to Washington after his trip to the Canal Zone, he decided to adopt the procedure suggested in my original communication. Accordingly, I received on Saturday, April 13th, a letter of his dated April 5th which was postmarked from Washington on April 12th, 5:30 P.M., - a delay which is understandable in view of the tragic international occurrence of the intervening week. In the wake of that letter I also received on the 13th a note from General Watson dated the 5th, and, in furtherance of a telephone call on Saturday, Dr. Briggs's letter of the 13th.

Naturally, having been brought into the orbit of this problem by Dr. Szilard, I have been in continuous touch with him at every stage of the developments and over this weekend and particularly today we have discussed aspects of the appropriate procedure for the forthcoming conference which the President has instructed General Watson and Dr. Briggs to arrange in conformity with the ideas implicit in your original letter. May I add that in the interest of assuring an adequate scale for the experimentation and a right tempo for the work it will be most helpful if you could see your way to attending, along with Drs. Wigner and Szilard, as I am sure that the President would feel all the more confident and would be delighted to know that any program that is worked out will have had your sagacious cooperation and your approval.

I am looking forward to seeing you and conferring with you before the meeting which, owing to the exigencies of conference and the development of a coordinate policy, might require postponement.

Yours sincerely,

Dr. Albert Einstein,
112 Mercer Road,
Princeton, N. J.

420 West 116th Street
New York City

April 22, 1940

Dr. Alexander Sachs
c/o Lehman Corporation
One South William Street
New York City

Dear Dr. Sachs:

In accordance with the letter written to you by Professor Einstein on March 7, I am submitting to you in the following a memorandum dealing with the present work on nuclear chain reactions. Only one aspect of the subject is discussed in this memorandum, namely its possible bearing on questions of national defense.

Memorandum.

We have to discuss separately two different types of chain reactions, i. e.

a) chain reactions in which the neutrons are slowed down, and in which only a small fraction of the uranium can be utilized, corresponding to the content of uranium 235 in ordinary uranium; (if ordinary uranium is used for the purposes of such a chain reaction, a ton of uranium will be exhausted after having supplied as much energy as corresponds to the burning of about 3000 tons of oil)

b) chain reactions in which the neutrons are not slowed down and in which the bulk of the ordinary uranium could be utilized; (if it were possible to maintain a chain reaction of this type in uranium, one ton of uranium could supply more energy than 300.000 tons of oil.

There is reason to expect that a chain reaction of the type described under a) can be maintained in a system composed of uranium and carbon.

Whether or not a chain reaction of the second type, as discussed under b), can be maintained in uranium is not known and has for the present to be considered an open question which, in view of its far reaching consequences, urgently requires further study.

Part I.

Chain Reactions maintained in Systems composed of Carbon and Uranium.

A chain reaction of this type is capable of applications which may have a bearing on questions of national defense.

1. A system composed of carbon and uranium might be used for purposes of power production. Questions relating to the transformation into power of the energy liberated in the chain reaction as well as questions relating to the regulation of the chain reaction have been studied, and methods for solving these problems have been devised.

Personnel has to be protected from being exposed to the radiations emanating from the chain reaction by means of water tanks, and such an atomic engine equipped in this way could be used as a power reserve in larger naval units. The weight of the water tanks rules out the possibility of using an atomic engine for the purpose of driving aeroplanes.

One ton of uranium would be capable of supplying about as much power as 3000 tons of oil. For instance, a 30.000 ton battleship, which would ordinarily have a maximum oil load of 4000 tons could in the future be equipped for the use of both oil fuel and atomic power and would carry perhaps 1000 tons of oil and 50 tons of uranium, the latter representing the equivalent of an oil reserve of about 150.000 tons. Accordingly, such a boat would have a practically unlimited cruising radius.

Since a battleship equipped with an atomic engine need not carry in war-time more than a normal oil load of perhaps 1000 tons, there would result a saving in weight, even if allowance

is made for the weight of the atomic engine. This saving in weight would lead to an increase in the top speed of the vessel.

The limited supply of uranium would make it inadvisable to use up any considerable amounts for naval purposes in peace time, and the atomic engines with which battleships may be equipped must not be used except occasionally in maneuvers and in case of actual warfare. Since a large battleship or battle-cruiser will use more than $\frac{1}{2}$ ton of oil per mile if cruising at an economical speed, it would exhaust its full oil load of about 4000 tons during a cruise covering about 10.000 miles. This means that a fast ship can not operate for any length of time at a distance of about 4-5000 miles from its nearest base. The advantage of a battleship having an equivalent of an oil reserve of 150.000 tons would in these circumstances be decisive, since apart from the increased speed it could stay for a long period near its objective at any distance from its base.

2. A system composed of carbon and uranium may be used as a weapon in the following manner: A chain reaction may be maintained in this system and the neutrons emanating from the chain reaction may be allowed to escape. The intensity of the neutron radiation could be made so high that this radiation would fatally injure by its physiological action human beings who are exposed to it within a radius of one kilometer. By mentioning this fact it is not desired to imply that such a system represents a desirable or particularly efficient military weapon. The reason for emphasizing this point lies rather in the belief that such a system could be used as a weapon by some other country during the present war, possibly in the near future, and that it could be used with considerable effect on a country which is not prepared to meet this new type of attack.

Part II.

Chain Reactions in which the Neutrons Are Not Slowed Down.

It is not known at present whether or not chain reactions of this type can be brought into existence. If, however, this could be done they would have a bearing on questions of national defense, going in their scope of applications far beyond the applications discussed in Part I.

1. In a chain reaction of this second type one ton of uranium used as driving power in a warship could supply more power than 300,000 tons of oil. Consequently, it would probably be possible for the larger types of naval vessels to dispense entirely with the use of oil.

2. A chain reaction of this second type would make it possible to bring about explosions of extraord nary intensity. If for purposes of aggression, a bomb baded on such a chain reaction were set off at sea near the coast, the tidal waves brought about by the explosion might lead to the destruction of coastal cities. Such a a bomb would not be too heavy to be carried by small boats, but could hardly be carried by existing airplanes.

Copy

420 West 116th Street
New York City

April 22, 1940

Dr. Alexander Sachs
c/o Lehman Corporation
New York City

Dear Dr. Sachs:

In accordance with the letter written to you by Professor Einstein on March 7, I am submitting to you the following memorandum dealing with the present work on nuclear chain reactions. Only one aspect of the subject is discussed in this memorandum, namely its possible bearing on questions of national defense.

Memorandum.

We have to discuss separately two different types of chain reactions, i.e.

a) chain reactions in which the neutrons are slowed down, and in which only a small fraction of the uranium can be utilized, corresponding to the content of uranium 235 in ordinary uranium; (if ordinary uranium is used for the purposes of such a chain reaction, a ton of uranium will be exhausted after having supplied as much energy as corresponds to the burning of about 3000 tons of oil);

b) chain reactions in which the neutrons are not slowed down and in which the bulk of the ordinary uranium could be utilized; (if it were possible to maintain a chain reaction of this type in uranium, one ton of uranium could supply more energy than 300.000 tons of oil).

There is reason to expect that a chain reaction of the type described under a) can be maintained in a system composed of uranium and carbon.

Whether or not a chain reaction of the second type, as discussed under b) can be maintained in uranium is not known and has for the present to be considered an open question which, in view of its far-reaching consequences, urgently requires further study.

Part I : Chain reactions maintained in a system composed of carbon and uranium.

A chain reaction of this type is capable of applications which may have a bearing on questions of national defense.

1. A system composed of carbon and uranium might be used for purposes of power production. Questions relating to the transformation into power of the energy liberated in the chain reaction, as well as questions relating to the regulation of the chain reaction, have been studied, and methods for solving these problems have been devised.

Personnel has to be protected from being exposed to the radiations emanating from the chain reaction by means of water tanks, and such an atomic engine equipped in this way could be used as a power reserve in larger naval units. The weight of the water tanks rules out the possibility of using an atomic engine for the purpose of driving aeroplanes.

One ton of uranium would be capable of supplying about as much power as 3000 tons of oil. For instance, a 30.000 ton battleship, which would ordinarily have a maximum oil load of 4000 tons could in the future be equipped for the use of both oil fuel and atomic power, and would carry perhaps 1000 tons of oil and 50 tons of uranium, the latter representing the equivalent of an oil reserve of about 150.000 tons. Accordingly, such a boat would have a practically unlimited cruising radius.

Since a battleship equipped with an atomic engine need not carry in war-time more than a normal oil load of pperhaps 1000 tons, there would result a saving in weight, even if allowance is made for the weight of the atomic engine. This saving in weight would lead to an increase in the top speed of the vessel.

The limited supply of uranium would make it inadvisable to use up any considerable amounts for naval purposes in peace time, and the atomic engines with which the battleships may be equipped must not be used except occasionally in maneuvres and in case of actual warfare. Since a large battleship or battlecruiser will use more than ½ ton of oil per mile if cruising at an economical speed, it would exhaust its full oil load of about 4000 tons during a cruise cavering about 10.000 miles. This means that a fast ship cannot operate for any length of time at a distance of about 4-5000 miles from its nearest base. The advantage of a battleship having an equivalent of an oil reserve of 150.000 tons would in these circumstances be decisive, since, apart from the increased speed, it could stay for a long period near its objective at any distance from its base.

2. A system composed of carbon and uranium may be used as a weapon in the following manner: A chain reaction may be maintained in this system, and the neutrons emanating from the chain reaction may be allowed to escape. The intensity of the neutron radiation could be made so high that this radiation would fatally injure by its physiological action human beings who are exposed to it within a radius of one kilometer. By mentioning this fact it is not desired to imply that such a system represents a desirable or particularly efficient military weapon. The reason for emphasizing this point lies rather in the belief that such a system could be used as a weapon by some other country during the present war, possibly in the near future, and that it could be used with considerable effect on a country which is not prepared to meet this new type of attack.

Part II : Chain reactions in which the neutrons are not slowed down.

It is not known at present whether or not chain reactions of this type can be brought into existence. If, however, this could be done, they would have a bearing on questions of national defense, going in their scope of applications far beyond the applications discussed in Part I.

1. In a chain reaction of this second type one ton of uranium used as driving power in a warship could supply more power than 300.000 tons of oil. Consequently, it would probably be possible for the larger types of naval vessels to dispense entirely with use of oil.

2. A chain reaction of this second type would make it possible to bring about explosions of extraordinary intensity. If, for purposes of aggression, a bomb based on such a chain reaction were set off at sea near the coast, the tidal waves brought about by the explosions might lead to the destruction of coastal cities. Such a bomb would not be too heavy to be carried by small boats, but could hardly be carried by existing airplanes.

signed: Leo Szilard

April 23, 1940
420 West 116th Street
New York City

Dr. Alexander Sachs
Lehman Corporation
1 South William Street
New York City

Dear Dr. Sachs:

I refer to the memorandum contained in my letter of April 22, and enclose a photo-stat copy of a short paper which I sent to the Physical Review and in which it is shown that a chain reaction can be maintained in a system composed of uranium and carbon. The publication of this paper as well as the publication of a detailed paper on the same subject is being delayed pending the outcome of the April meeting of the Special Advisory Committee appointed by the President.

With reference to Point 2 of Part I of my memorandum I have asked Dr. G. Placzek at ~~Columbia~~ Columbia University ~~of New York~~, to submit a memorandum on the subject of the propagation of neutrons liberated in the chain reaction in air along the surface of the earth or along a water surface, and I am herewith forwarding ~~the~~ his memorandum ~~which he prepared on this subject~~. My statement that human beings could be killed within a radius of 1 kilometer by the physiological action of the radiation is consistent with the calculations carried out by Dr. Placzek. I am sending you both enclosures so that you might put them before the April meeting of the Special Advisory Committee. If the Committee ~~also~~ should want a copy of my detailed paper ~~on chain reactions in a system composed of carbon and uranium~~ I should be

glad to send ~~a photo-static copy~~ one on request.

Yours sincerely,

(Leo Szilard)

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ENC.

used in large quantities in the ultimate experiment, and obtaining bids for the manufacturing of such material in the required quality and quantity. An expenditure of $ 50.000 would probably be sufficient to bring this first stage in the organization of the large scale experiment to its conclusion, so that we would be in the position of entering into the second stage of the work, provided that the result of the proposed survey of the nuclear constants is favorable. In this second stage the expenditure would gradually rise and might reach a total of $ 500.000 by the time when the large scale demonstration experiment will be completed.

If a fund were set up under the direction of a board of trustees who had the confidence of the Government, as set forth in the letter by Dr. Einstein that was written following his conversations with you and read by Dr. Briggs at the meeting of April 27, Dr. Fermi and I would be glad to accept the responsability for carrying out this work under the direction of such a board, and would be pleased to have our work supervised by a small committee of scientists who might be entrusted with the task of advising the board.

In my personal opinion, it would be advisable that the proposed small committee of scientists be left some latitude in devoting, as was suggested at the last conference, up to 25% of the total expenditure for investigating the possibility of a fast neutron reaction. It is further my personal opinion that, if the study of the separation of the uranium isotope were to be included in the program of work, then Dr. Urey of Columbia and Dr. Beams of the University of Virginia ought to be asked to accept the responsability for the direction or coordination of this line of work in the same way in which Dr. Fermi and I are prepared to take upon ourselves the responsability in connection with the work on commercial, unseparated, uranium.

Yours sincerely,

signed: Leo Szilard

420 West 116th Street
New York City
May 10, 1940

Dr. Alexander Sachs
c/o Lehman Corporation
One South William Street
New York City

Dear Dr. Sachs:

Our work concerning systems composed of carbon and uranium has how reached a stage at which it seems necessary to organize a large scale experiment. Only through actually carrying out such an experiment can it be demonstrated beyond doubt that a nuclear chain reaction can in fact be maintained in a system composed of carbon and uranium.

Since it appears necessary and urgent to obtain certainty in this matter we desire to start organizing a large scale experiment. This experiment would require about 100 tons of graphite and perhaps 10 to 20 tons of uranium metal. It would also require elaborate mechanisms designed to stabilize the chain reaction and to safeguard against over-heating and the possibility of an explosion. Realizing that this is an enterprise which may require to its conclusion an expenditure of $200,00 to $500,000, we propose to carry out this project in successive stages. If the results obtained during the first stage are satisfactory, then the expenditure necessary for the second stage would appear to be justified, and the second stage could be started according to schedule, etc. If this procedure were adopted, then the expenditure would gradually rise parallel to the increase in our assurance of the smooth functioning and the final success of the large scale experiment.

In the first stage we would propose to carry out a general survey of all nuclear constants involved with a view to confirming the values previously obtained and to narrowing down the limits of experimental error of the observed values of these constants. A successful conclusion of this survey would strengthen our assurance of the ultimate success of the experiment and would enable us to find the optimum condition for its performance. Concurrently, with this survey, certain other work would have to be done in order to prepare the ground for the experiment. Such work would include the designing of constructional details, the carrying out of technological tests on samples of materials which have to be used in large quantities in the ultimate experiment, and obtaining bids for the manufacturing of such material in the required quality and quantity. An expenditure of $50,000 would probably be sufficient to bring this first stage in the organization of the large scale experiment to its conclusion, so that we would be in the position of entering into the second stage of the work, provided that the result of the proposed survey of the nuclear constants is favorable. In this second stage the expenditure would gradually rise and might reach a total of $500,000 by the time the large scale demonstration experiment will be completed.

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Yours sincerely,

Leo Szilard
(Signed)

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420 West 116th Street
New York City
May 10, 1940

Dr. Alexander Sachs
c/o Lehman Corporation
One South William Street
New York City

Dear Dr. Sachs:

Our work concerning systems composed of carbon and uranium has now reached a stage at which it seems necessary to organize a large scale experiment. Only through actually carrying out such an experiment can it be demonstrated beyond doubt that a nuclear chain reaction can in fact be maintained in a system composed of carbon and uranium.

Since it appears necessary and urgent to obtain certainty in this matter we desire to start organizing a large scale experiment. This experiment would require about 100 tons of graphite and perhaps 10 to 20 tons of uranium metal. It would also require elaborate mechanisms designed to stabilize the chain reaction and to safeguard against overheating and the possibility of an explosion. Realizing that this is an enterprise which may require to its conclusion an expenditure of $200,000. to $500,000. we propose to carry out this project in successive stages. If the results obtained during the first stage are satisfactory, then the expenditure necessary for the second stage would appear to be justified, and the second stage could be started according to schedule, etc. If this procedure were adopted, then the expenditure would gradually rise parallel to the increase in our assurance of the smooth functioning and final success of the large scale experiment.

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probably be sufficient to bring this first stage in the organization of the large scale experiment to its conclusion, so that we would be in the position of entering into the second stage of the work, provided that the result of the proposed survey of the nuclear constants is favorable. In this second stage the expenditure would gradually rise and might reach a total of $500,000. by the time when the large scale demonstration experiment will be completed.

If a fund were set up under the direction of a board of trustees who had the confidence of the Government, as set forth in the letter by Dr. Einstein that was written following his conversations with you and read by Dr. Briggs at the meeting of April 27, Dr. Fermi and I would be glad to accept the responsibility for carrying out this work under the direction of such a board, and would be pleased to have our work supervised by a small committee of scientists who might be entrusted with the task of advising the board.

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Yours sincerely,

Leo

signed: Leo Szilard

[illegible]

May 30, 1940

MEMORANDUM for Dr. Sachs

Please find enclosed memorandum for Dr. Urey of May 30, 1940. In addition to the items included in the above-mentioned memorandum the following points seem to require attention.

a. It is important that Dr. Urey and the non-governmental members of the Special Advisory Committee be authorized to investigate whether there is a possibility of mining uranium ore in the Belgain Congo and transporting it to this country under the present conditions. If it is considered premature for the Government to buy any uranium ore perhaps some arrangement could be made with Dr. Sengier, the managing director of the Union Miniere who is at present in New York, or through the Belgian Government in exile that uranium ore be brought to the United States with the assistance of the United States Government, the Belgian company retaining the title of this ore but committing itself not to re-export it without special permission. It is impossible to know whether such and other alternative solutions are feasible, unless a preliminary inquiry is made, and it is not advisable to make such an inquiry without proper authorization.

b. It appears necessary that some experimentation be started at once by industrial firms who are willing to supply 10 to 20 tons of uranium metal at about six months notice. It is necessary that the non-governmental members of the Special Advisory Committee and Dr. Urey should be in a position of approaching ~~[illegible]~~ industrial firms on this subject and should feel authorized to do so.

c. It would be desirable that Dr. Urey and the non-governmental members of the Special Advisory Committee should form the nucleus for a board of trustees and work out the ~~standards~~ statutes for some

Ph

for some non-profit organization which would ~~as far as the physicists in the universities are concerned form the link~~ act as a link between the Government and the university laboratories. If such an organization were formed the physicists ought to be encouraged to take out patents for their inventions which would be assigned either to this non-profit organization or direct to the Government. In any case the Government would thus be safeguarded against having to pay royalties for the use of such inventions, which otherwise might be patented by industrial firms whose research employees begin to show increasing interest in this field of development.

In this connection the question has to be raised whether it is possible to keep such patents secret. In order to do so in an adequate way it might be advisable to modify the present law if necessary. Such a modification of the present law ought of course not to be made exclusively with a view to inventions concerning chain reactions but also with a view to all inventions which have important applications in national defense. The physicists and engineers ought not to be deprived of the stimulus arising out of the possibility of patenting their inventions and at the same time collaborating with the Government in ~~their~~ the effort to keep certain of these inventions secret.

August 28, 1940.

Dr. Alexander Sachs

Dear Dr. Sachs:

Enclosed you will find a rough draft which I am certain you will want to change in many places.

I am sending it to you in advance of my visit which is scheduled for 5 p.m. , so that you may be able to redictate it if you wish to do so before we discuss it orally.

Yours very sincerely,

(Leo Szilard)

August 27, 1940

In September last year I was approached by a group of scientists with the request of helping them to enlist the support of the Government for a line of work which might be of great importance for the U.S. Navy. Thereupon ~~After having studied the matter~~ the attention of the Administration was drawn to this line of research and its potential possibilities by a letter written by Professor Albert Einstein, which was addressed to the President and which I transmitted to him in a personal interview.

According to the scientists who work in this field it will be possible to liberate energy in uranium by means of a cchain reaction, and it appears likely that it will be possible to utilize the energy liberated in the chain reaction for power production. It has yet to be demonstrated though that a chain reaction can in fact be maintained in a mass of about 30 tons of ordinary uranium of such purity as can be obtained by applying methods of ordinary chemical engineering. A conservative estimate shows that we may expect one ton of uranium to supply as much power as about 3000 tons of oil, but pending the outcome of certain newer experiments there is a 50:50 chance that one ton of uranium may supply as much power as would correspond to 1 million tons of oil.

If one ton of uranium supplies as much power as 3000 tons of oil then a power plant of this type could be installed on warships of the larger type and serve as a reserve driving power to be used in war time, which would seem to be of part-

icular significance for the United States in case of a war with Japan. This can be seen from the following consideration;

The naval base at Hawaii is at a distance of 3400 miles from Japan. A capital warship which carries a maximum load of about 4000 tons of oil will use about ½ ton of oil per mile if cruising at a satisfactory speed. It has therefore to be refueled after traveling 8000 miles. In the circumstances such a ship, if it is refueled at Hawaii, could cruise at high speed only for a very short time in the vicinity of Japan proper. Assuming that it may be possible for the Navy to obtain 300 tons of uranium per year it might be possible to equip six boats every year with a plant ~~comprising~~ stocked with 50 tons of uranium and representing an oil reserve of 150.000 tons. This would enable these boats to have in war time a cruising range which is no longer limited by the necessity of refueling. Moreover, ~~a considerable~~ increase in speed may be achieved by reducing the oil load from 4000 tons to perhaps 1000 tons, resulting in a reduction of weight which is only partially compensated by the weight of the additional equipment of the uranium power plant. Assuming that one ton of uranium corresponds to only 3000 tons of oil, it would not seem likely that uranium can replace oil as a driving power for capital ships, but we may expect it rather to play the role of a reserve driving power to be used only in war time and at manoeuvres. Should further experiments, however, show that one ton of uranium can supply as much power as 1 million tons of oil, then capital ships could be equipped with this new source of power exclusively and do away with oil altogether.

In that case the present capital ships may become considered as obsolete.

2. Present Status.

The above-mentioned line of development is pursued by Dr. Fermi and Dr. Szilard in the laboratories of Columbia University. ~~Another~~ second line of research, which is followed up by Dr. Urey at Columbia University and also at several other places in the United States, represents an entirely different approach and aims at extracting from ordinary uranium a substance called uranium 235. There is no doubt that, if this substance can be extracted on a sufficiently large scale at a reasonable price, it could be used as a source of energy for purposes such as described above. I understand that this second line of research is at present adequately supported both by the Army and Navy, whereas the first line of research, which promises practical results in a much nearer future, is at present not adequately organized. The state of affairs with respect of this first line is at present as follows:

Dr. Fermi and Dr. Szilard are proposing to carry out certain experiments at Columbia University. It is assumed that Dr. Bush's committee will meet the expenses of these experiments. A Special Advisory Committee headed by Dr. Briggs, which comprises representatives of the Army and Navy as well as Professor Pegram, Professor Einstein and myself, has concerned itself with various aspects of the work of Dr. Fermi and Dr. Szilard, including the necessity of its support. A committee of scientists headed by Dr. Urey is supposed to advise the Special Advisory Committee. The relationship of all these committees to

each other and to Dr. Briggs' committee is rather unclear.

3. Shortcomings of the present status concerning the organization of the line of work ~~represented~~ pursued by Dr. Fermi and Dr. Szilard.

The production of a chain reaction in uranium in circumstances which are suitable to be utilized in an engine capable of driving a naval vessel is a task of considerable complexity. This task cannot be carried out by a loose cooperation of various committees and universities. It requires planning, the preparation of experiments six months and occasionally one year ahead, the gathering of a group of physicists prepared to collaborate for a number of years, whose loyalty has to be with this work rather than with the individual teaching institutions with which they happen to be associated. At present we may assume that the work carried out at Columbia University will be supported by Dr. Bush's committee, but it ~~remains to be seen how much of~~ is unlikely that this complex task can be carried out at a single university where the available space and the necessity of maintaining the routine work carried out by the department will naturally limit the ~~x~~ speed at which the work should be carried out. ~~The~~ A loose cooperation between various universities can be anticipated and may to some extent remedy the situation, but surely this is no way of obtaining quickly the desired results. The existing committees both by virtue of their composition and by virtue of their structure can hardly be expected to fulfill the function which is required. This is fully borne out by the experience gathered during the ~~past year. For this reason the history of the past year is summarized in the following:~~ last 10 months

4. ~~History.~~ ~~Experiments~~ Work past year (10 months)

In order to test the possibility of maintaining a chain reaction in ordinary uranium Dr. Szilard proposed last year to carry out an experiment using 100 to 200 tons of graphite and 20 to 30 tons of uranium metal. A successful conclusion of such an experiment may ultimately involve expenses up to half a million dollars, and in October last year I made an appeal to the Government for its moral and material aid in carrying out this project. In response to a letter received from Professor Einstein the President appointed a committee, with Dr. Briggs as chairman, and I submitted the matter to this committee jointly with Dr. Szilard, Dr. Wigner of Princeton University and Dr. E. Teller of George Washington University, Washington, D. C. We emphasized the urgency of deciding the question whether a chain reaction could be made to work with ordinary unspparated uranium, so that in case of a favorable result, steps might be taken to secure an adquate supply of rich uranium ore from the Belgian Congo. It was also pointed out that the matter had been discussed extensively with Professor E. Fermi and Dean G. B. Pegram of Columbia University, that their collaboration could be counted upon, and that certain preliminary experiments were being prepared at Columbia.

The Government representatives expressed their interest and their desire to help at this meeting, and various Government departments represented on the committee promised material aid towards the preliminary experiments (which have since been carried out to their completion at Columbia with ~~a definitely~~ an encouraging result). A favorable report was sent by Dr. Briggs' committee to the President in October.

A number of meetings, with constantly varying membership, have taken place between October of last year and July this year, at which the Government representatives showed a steadily increasing desire that the proposed project be carried out with Government funds rather than private funds. The representatives of Columbia University - Dr. Fermi, Dean Pegram and Professor J. C. Urey - played an increasingly prominent part in these conferences, as well as Admiral Bowen of the Naval Research Laboratory.

In spite of the increasing favourable reaction of the Government representatives little headway was made during the past ten months, either towards organising and financing the nessecary experiments or towards securing an adaquate supply of uranium ore for the future from the Belgian Kongo, which is the most important source of highgrade uranium ore.

At present it may be assumed that the experiments which will be carried out at Columbia University will find financial support trough Dr. Bush's committee, but if each nessecary step requires ten months of deliberation than abviously it will not be possible to carry out this development efficiently. Since April of this year it has been known that work on uranium is proceeding in Germany in great secrecy and on a very large scale in two of the Kaiser Wilhelm Institutes under the auspices of the German Government. This is precisely what was predicted bei Prof. Einstein in his above mentioned letter of September last year.

5. Suggestions:

In order to insure that the task before us is carried out with the efficiency of a going enterprise it is proposed that it be entrusted to a non-profit orpanisation which is formed for the purpose. The scientists responsible for devising this project and who are familiar with the various aspects of this complex material ought to be included in the executive and ought to be in direct touch with Dr. Bush and such other government representatives as are interested in the details of the project. Large scale experiments ought to be carried out as a joint enterprise of this organisation and Columbia University and such other universities as may be willing to collaborate and to put up required space and other facilities. It would be the responsibilty of this organisation:

1.) to see to it that all necessary experiments be carried out at one place or another and

2.) to see to it that all necessary materials be available for such experiemtns in the required quantity and quality.

3.) to find out in what form if any collaboration with industrial organisations such as for instance Westinghouse, General Electric and Dupont is desirable and possible, and if desirable to establish such collaboration.

4.) To maintain contact with the Canadian and U.S. producers of uranium and to stimulate if necessary an expansion of the production.

5.) To advise the government in general and the Secretary of the Navy in particular of the developments and to prepare the ground for transferring gradually transfering the experience acquired to the Navy at the appropriate time.

It may be mentioned that this form of organisation has been repeatedly discussed at previous meetings and an opinion strongly in favour of it has been expressed by Prof. Einstein in a letter addressed to Dr. Briggs, a copy of which is enclosed.

It is proposed that the seat of the organisation be in New York City , that the board of trustees include the names of Prof. Pegram, Prof, Urey, Prof. Laurence, Prof. Du Bridge, Prof Wigner Dr. Sachs and if government employees be included the names of Dr. Briggs and Admiral Bowen. It is proposed that Prof. Pegram be chairman of the board and Dr. Sachs act as treasurer.

It is proposed that the executive be composed of Dr. Pegram, Dr. Urey, Dr. Fermi, Dr. Szilard and Dr. Sachs , all of New York City and that a committee of scientists be responsible for supervising all the work which committee includes the names of

H.C. Urey

M.A. Tuve

G. Breit

G.B. Pegram

E. Fermi

L. Szilard

E.P. Wigner

E. Teller

It is proposed that a fund of $ 20.000 be put at the disposal of the such an trustees of this organisation .

CLASS OF SERVICE DESIRED	
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WESTERN UNION

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R. B. WHITE, PRESIDENT — NEWCOMB CARLTON, CHAIRMAN OF THE BOARD — J. C. WILLEVER, FIRST VICE-PRESIDENT

CHECK

ACCOUNTING INFORMATION

TIME FILED

Send the following message, subject to the terms on back hereof, which are hereby agreed to

To Alex Sachs — Mai 31st 19

Street and No. Hotel Carlton

Place Wash D.C.

Inquiry indicates that modification of law enabling government to have patents granted but kept secret would be of advantage but not absolute necessity. Szilard

Sender's address for reference

Sender's telephone number

Statement by Dr. Sachs.

Early in March I ~~xxx~~ received a letter by Dr. Einstein, in which he informed me that he had learned from reliable sources that work on uranium in Germany is being carried out in great secrecy and on a very large scale. I understand that this information is confirmed by Prof. Debye who recently came from Germany. Dr. Einstein wrote me that Dr. Szilard has written a detailed paper on the possibility of chain reactions in a system composed of uranium and graphite, and that this paper has been sent to the Physical Review, and Dr. Einstein raised the question of secrecy in connection with all this work. At the same time, Dr. Einstein asked Dr. Szilard to submit a memorandum on the possible bearing of Dr. Fermi's and Dr. Szilard's work on questions of national defense, which memorandum I have in the meantime received. Accordingly, I submitted his communication to the President, and upon the President's return from his trip in the Canal Zone I was advised by him that he had asked his Secretary, General Watson, to arrange another meeting in Washington, with Dr. Briggs and the representatives of the Army and Navy ~~xxxxxxxxxxxx~~ and others. General Watson, on the same date, asked for suggestions from Dr. Einstein and myself as to the supplemantary names for attendance at this conference, and so, through the kind offices and direction of Dr. Briggs, this conference has resulted.

This week, having heard from Dr. Einstein that he could not attend, I had the pleasure of calling on him and hearing his views. He told me that he had discussed the scientific aspects with Dr. Wigner and emphasized his conviction as to the importance of creating conditions under which the work can be pursued on an adequate scale . He also discussed some aspects of organization and

sought my views on that, but this can be deferred for a later stage of this conference.

U. 1934 Congo 100000 lbs

Canada 27000

Chechoslovakia 27000

Portugal 88000

1938 U. S. 51000

1937 Canada 200000 lbs

Ra Canada 70 gr

235.3
705

16.8
128

100 tons graphite

6 " U.