Dear Liebowitz,

Delbrueck telephoned to me from Berlin after he has talked with Laue . Laue wished that I should get in touch with Ehrenfest . (He also emphasised very much that nothing should be published) So I got in touch with Ehrenfest whom I went to see in Leiden. D. told me on the phone that Ehrenfest organised something along the same lines but I found literally nothing. I believe if we want to achieve something in Amerika before the term is o we ought to go over soon . Ehrenfest could come along betwween June 2 and July 4 he must be in Leiden on these days. I found out that he also was a little worried about 300 Gulden which he would loose if he were absent in June (some examination fees) I think that if Bohr, Ehrenfest Stamp and ourselves would stir up the people we could achieve something. Ehrenfest couldv represent on one Hand the german Physicists and on the other hand he could represent Einstein.

Ehrenfest has a small fund to invite theoretical Physicists for a few mo and I shall try to get the Belgians to invite the same people when they leave Holland. The Leading people in Berlin are quite desperate and at a loss. Seven people have been dismissed from the Phycalisches Institut in Berlin among the younger set . All coworkers of Lan (Brasch and Lange) for instance ; I am very much impressed and quite determined to make further efforts.

Please read enclosed report of Ehrenfest (confidential) and have i and the enclosed List copied.

In Paris I shall stay probably in the Hotel Terminus Nord but not cert this is

Therefor you better note also Marschaks Adress

22 rue Theophil Gautier Paris 16. Telephone Auteul 3914.

I write this on the train to Geneve, where I go with Prof Fryda of Ams

dsmm and where I meet also Dr. Schlesinger,we proceed all of us then to Paris . I shall be in Paris either on Monday or on Tuesday and shall wire you date and adress; also whether you are strongly wanted or just welcome You can then decide according how important your beeing in London for the moment happens to be and according how it fits into your o ther plahs whe ther it is more advisable for you tostay in London or to come to Paris In any case we are wasteing our time if we do anything else but stimulate ing America and the next week must be devoted toprepare some action in America.

Yours L. Szilard

c/o B.Liebowitz
420 Riverside Drive
New York City.

Dear Mr.Malin:

Many thanks for the drawings which arrived in due time. Enclosed I am sending you the specifications and claims for the English complete specifications which has to be filed before April the 12th. Since the first provisional was filed March 12th last year. Please note that a fee has to be paid for exceding the time limit of one year.

The following provisional specifications have to be quoted in the present complete specifications :

March 12,May 9,June 14,June 28,July 4,Sept.20,Sept.25.

I am also enclosing the drawings on which I have marked by pencil the figure number,perhaps you can write it on by ink.

Could you kindly send me a cable when you have looked through these documents and find that things will go in order.

Many thanks for the trouble you take in this matter.

Yours very truly

New York,March 17th,1935.

BENJAMIN LIEBOWITZ.

American Express Company,
L O N D O N.

4th May, 1933.

Dr. Ernst P. Boas,
1185, Park Avenue,
NEW YORK CITY.

R-7

Dear Ernst,

I am writing to you instead of to your father because personal matters will creep in ; but turn this letter over to him as soon as possible.

It is impossible to describe the utter despair of all classes of Jews in Germany. The thoroughness with which they are being hunted out and stopped short in their careers is appalling . Unless help comes from the outside, there is no outlook for thousands, perhaps hundreds of thousands, except starvation or veronal. It is a gigantic "cold " pogrom. And it is not only against Jews; Communists of course are included, but are not singled out racially; social democrats and liberals generally are now or are coming under the ban, especially if they protest in the least against the Nazi movement. Please note that I am not speaking from hearsay; I know people, friends in many classes - scientists, scholars, doctors, lawyers, business men, economists, etc.

I shall not go into details; an example or two will suffice. At Göttingen there are just two professors and three assistants left in the mathematics department - lately the most important mathematical center in Germany. At Kaiser Wilhelm Institute Haber, Polanyi, Freunlich have resigned. Probably you have seen lists of professors of economics, law, etc. who have been "beurlaubt" . I am enclosing one such list taken from the Berliner

Tageblatt about three weeks ago. Large Jewish firms have been compelled (in some cases the compulsion was not adequate) to lay off all their Jewish employees; for example Tietz of Köln dismissed about one thousand . I met one of the dismissed men in Amsterdam.

The Nazi rank and file seem to do things largely as they wish . The first government edict against Jewish lawyers threw about 2500 in Berlin alone out of their means of livelihood; the second decree softened the blow by stating that those who fought in the trenches or lost a father or a son in the war would be reinstated, thus presumably restoring about 1400 out of the 2500; but Kerl, the Prussian Justizminister, issued a statement that on account of the strong attitude against Jews in the courts etc., it might take years to carry out this reinstatement; then the Government issued another decree that the matter must be cleared up by May 8th; then Kerl responded by a statement that Jewish lawyers must fulfil certain <u>personal</u> requirements to insure that they would be in accord with the national movement before they would be reinstated. That is where the matter stood when I left Berlin April 30th. All this just to give you some feeling of the actual state of affairs.

About March 1st. Elsbeth went to Copenhagen with the family with whom she had been staying (Dr. Philipsborn's family). March 20th Virginia and Naomi went to Paris. I remained in Berlin until after the boycott and met V . and N. in Amsterdam on April 4th. We remained in Holland about a week then went to Copenhagen, then, after another week, Virginia and I returned to Berlin leaving Naomi and Elsbeth with Mrs. Philipsborn. On April 30th. V. and I left Berlin for London. I have done none of my own work for the last

six weeks or more and the emotional and intellectual upsets are not condusive to formulating further plans for study. When I first left Berlin (April 4th) I felt that since I am foot-loose and have some cash in the bank I ought to return to Berlin and pitch into some relief work of some sort; in Amsterdam the Chief of the Jewish Relief Committee expressed exactly the same view; that is one reason for my return to Berlin from Copenhagen. But once back in Berlin I found that by giving a few hundred Marks here and there I would quickly dissipate my resources with very little result. Moreover, I had been in close touch with another movement, and come now to the main part of this long letter.

I had spoken to you of my friend Dr. Leo Szilard whom I met in New York last spring. I saw a good deal of him in Berlin and can say that he proved to be the best prognosticator - he was able to foresee events better than anybody else I knew. Weeks before the storm broke he began to formulate plans to provide some means of helping the scientists and scholars of Germany. About the same time that I decided to do relief work he decided to throw his efforts into reconstruction work for the intellectuals - in which I have joined ~~them~~ him. It was in this connection that I had those conversations in Copenhagen with Niels Bohr, about which I cabled you. I do hope that you succeeded in bringing him together with your father, and I am most anxious to know the outcome of this meeting.

Now, as to the plan itself; it aims to form a central "International Board of Scientists and Scholars" whose main functions are to be as follows;

1. To stimulate, cooperate with and coordinate groups or committees for raising funds in the various countries throughout the western world.

2. To maintain contact with all interested universities which are in podition to accept fellows recommended by this board, the stipends coming from funds raised by the various national committees.

3. To make recommendations regarding the award of fellowships to qualified men who would otherwise be unable to continue their work.

The organisation is to be a loose one, i.e. the central board is to be strictly neutral and not of specifically Jewish character, although the various national committees may be as partisan as they please. It is important to maintain neutrality of the central board, so that men receiving fellowships will not be "ear-marked"; the families or connections of such men might be selected for special persecution in Germany. Fellowships could be named after specific doners if desired. At present the budget is calculated to provide at least 200 fellowships at 1000 Dollars per year for five years, making a total of one million Dollars. Personally I think the number of men to be helped must be at least doubled. The plan includes all natural and social sciences, i.e. university men and the like, but does not include practising physicians and lawyers. The latter groups must be cared for by some more general scheme; in any event their numbers are far too great to be handled by this contemplated means. Even among the men included in the plan, it is assumed that the more important professors and such will have little trouble getting new positions. The plan is mainly to help the large group of younger men, and it will be the task of the central board to select and recommend from these those who are to receive fellowships. This does not mean that the older men who are less fortunate are to be excluded in any way. It is to be expected that many of the fellows will make permanent connections with the universities to which they go, so that in the course of a few years the special assistance tendered them could be withdrawn.

The plan is making excellent progress in England. Szilard has been in consultation with the following men:

Prof. Niels Bohr -	Physicist -	Copenhagen.
Prof. Harald Bohr -	Mathematician	"
Prof. Hardy -	Mathematician	Cambridge.
Sir. William Beveridge. -	Director,	London School of Economics
Prof. Harold Laski -	Political Theory -	London School of Econo
Prof. A.V.Hill -	Physiology -	Nobel Laureate
Sir John Russell -	Agricultural Chemistry -	Director of Rothamstead Laboratories.
Prof. Mawr. -	Provost of London University.	
Prof. Donnan -	Physical Chemistry -	University College.
Dr. Karl Schlesinger	Banker and Economist -	Vienna.
Dr. Gotfried Kunwald	Lawyer -	Vienna. (Politically important)

The plan as outlined above, is in accord with the consensus of opinion of these men. Beveridge is particularly active. He is in contact with the Vice-Chancellors of London, Cambridge and Oxford Universities, and there is hope for a concerted movement to raise funds and to win the active aid of the English Universities.

Szilard is also in touch with Sir Philip Hartog and has attended meetings of a committee of which Sir P.H. is the chairman. This committee has been appointed by the Jewish Board of Deputies and the Anglo-Jewish Association; it also is concerned with the problem of the research workers and students. To-morrow, Sir P.H. and Sir William Beveridge will meet; some way of coordinating those two groups is expected.

Another movement, in which Dr. Weizman is expected to play the leading role, aims to enlarge the Hebrew University at Palestine. This situation is typical of what we must expect - a plurality of movements with the same general purpose but different immediate objectives, which will work more or less independently and often at cross purposes. Strong leadership is necessary to coordinate these movements for maximum efficiency. I

believe
it is necessary to select, as soon as possible, a list of important names among scientists and scholars who will accept positions on the above-mentioned international board. This is an immediate and important task. Those consulted here, like Niels and Harald Bohr, want some assurance that the project will be backed financially, and of course important donors will want some assurance that first-rate men will serve on the board. I think that any of the men mentioned above are ready to serve. As soon as there is some assurance about funds, the thought is that some very prominent man like Rutherford or Niels Bohr should be asked to form the central committee from a list of names whose consent had previously been obtained. This list must include men from all countries and all branches of science, and must be whittled down in making the final selection. Here is one of the places where your father could be of invaluable assistance. I would ask him if he would prepare a list for the U.S. and if he would write to the men he selects for their provisional consent. Similar steps are being taken here. Of course there will probably be some overlapping, but this is not harmful. The people addressed should be asked to forward copies of their replies to Dr. Leo Szilard, Hotel Imperial, Russell Square, London.

Another point: Would your father himself consent to serve on this international board?

As a result of a conference with Harold Lasky this morning I have important information to add. In the first place by a unanimous vote the staff of the London School of Economics agreed to contribute 1000 pounds a year for three years out of their salaries. This definitely starts the fund raising in England. It is hoped that the other important universities will follow the same example. In the second place, it was decided that the London School of Economics will invite three of the dismissed German professors as guest professors for three years. Further, Sir William Beveridge had a conference with the Vice-Chancellor of London University and the movement to coordinate London, Oxford and Cambridge in a concerted drive looks exceedingly hopeful. Professor Lasky expressed the hope that similar movements will soon be started in American universities. He also made the suggestion that your father should get in touch with Frankfurter who, probably through Brandeis, could induce Eugene Meyer to contribute a very substantial sum. It is very likely of course that ideas of this sort are not new to you, but I am passing them on for what they may be worth.

Thinking that the European perspective of American academic life might be advantageous, I asked Lasky to suggest American names for the proposed international board. At the same time, Szilard put the same question to Professor A.V.Hill. The following list is taken from these suggestions:-

Taussig	-	Economics -	Harvard.
Lang Muir	-	Chemistry -	General Electric Co.
John Dewey	-		
William Welch	-		
T. H. Morgan	-		

Arthur Schlesinger - History - Harvard.
Roscoe Pound - Law - Harvard.
Harvey. Cushing -
W.B.Cannon or Alexander Forbes Harvard.
- Physiology
C. E. Hale - President of National Council of Scientific Research.

These names are merely suggestions; American representation on the proposed international board will have to be decided in consultation with America of course. I might mention that Lasky also suggested two university presidents, Hutchins and Angell, but it seems doubtful if executives would be appropriate for this type of board. You will notice that our list is deficient in the mathematical and physical sciences; both Szilard and myself feel that neither of our two Nobel Laureates in Physics are entirely suitable; the names of Bridgman in Physics and Veblen in Mathematics have been suggested here, but they are not among the most prominent in their respective fields. But again I want to urge that what I say here in reference to the list of names is not important.

It is very important, however, toimpress upon everybody that the whole matter must be kept absolutely quiet outside of the circles immediately concerned, until all preparations are thoroughly completed. Furthermore, it is important to make it clear to the men addressed that the provisional list of those who give their consent to served on this international board will have to be whittled down when it comes to making the final selection. I should add that Harold Lasky advised me this morning that he expects the negotiations between the three Vice-Chancellors and Beveridge to bring in the most important names in British academic life and that they wi ll shortly invite Lord Rotherford to form this board. It is therefore advisable that American names

be secured as quickly as possible. I should have written you all of this weeks ago, but the whole situation has been so diffuse that clear cut information was not available earlier.

Naturally there will be more discussion and suggestions. It is very likely that I shall cable you about the time you receive this letter. In order to assist in coordinating the movements, it is quite possible that someone from here will go to the U.S. in a few weeks, perhaps Szilard or (Hoffentlich nicht) myself.

In order that you may have some sort of picture of the movements here, I am sending you herewith copies of the following correspondence:

From Dr. Schlesinger, Vienna, to Dr. Szilard.
From Dr. Rosenfeld, Brussels, to Dr. Szilard.
From Dr. Szilard to Sir. William Beveridge.

From the first of these letters you will note that Frau. Dr. Brunswick (daughter of Judge Mack) is writing to people in U.S., that they are being asked to cable their replies and that she will then ask Bohr and your father to get in touch with them.

I am fully aware of the burden I am uncerimonously trying to thrust upon your father's shoulders, but it is natural that his name should suggest itself immediately to those familiar with the German situation, and it is merely an accident that I happened to be the first to try to enlist his aid. It is of the utmost importance that we know immediately if the burden is too much, and I hope you will cable me as soon as you can and let me know if your father is in position to undertake the work.

Again I want to urge you to limit all information concerning this movement to those immediately concerned.

P.S. I have mentioned something about the situation of the Jewish lawyers in Germany; the plight of the practising physicians is even worse. Aside from the general edicts throwing all Jews out of government office, no special decrees have been issued against the doctors. But 90% of them depend for 90% of their income on the Krankenkasse, which are mostly private institutions; the Jewish doctors are being ruthlessly forced out of the Krankenkasse by the Nazi party, aided by a set of new official rules which, although not specifically directed against them, are carefully designed for use in discriminating against Jewish doctors. I have no official figures available but I believe that there are at least 10.000 or more Jewish doctors in Germany, most of whom are in a desperate situation. Their numbers, like those of the lawyers, are far too great to be helped by the special movement described here; tehy will have to be helped by some more general plan of relief. Don't let anybody tell you that "Gruelpropaganda im Ausland" has made or is making the lot of the German Jews worse; the Nazi government is proceeding with one of the most damnable pogroms in history, and has seized upon this fairy tale as one of the excuses. And what is even worse, many of the German Jews themselves believe that the foreign reaction to the Nazi brand of anti-semitism is really partly responsible for their woes. I tell you that one cannot make it too plain to the American public that this is one of the most hideous pieces of barbarity in history. One hears that even Mussolini is against it, and that is why Goering was made the guest of Balbo - a Roman Jew.

c/o B. Liebowitz
420 Riverside Drive
New York City

December 28th, 1938

Dear friend:

Forgive me please for writing this personal letter in such an impersonal form and for attempting to give you advice for which you did not ask. I have been wanting to write to you about these things for quite a long time, but there were so many other things that needed immediate attention.

This last year I have spent mostly in New York and have been following with anxiety European events. After the Munich agreement I have asked for "leave of absence without pay for an indefinite period" from Oxford, and I feel now free to stay here as long as I wish. It seems to me that we have to expect for many years to come ever increasing insecurity in Europe and that Egypt will gradually become one of the most exposed parts of all. I think you ought to take right now precautions to protect your family and yourself against future events.

Unfortunately such precautions are not quite simple and likely to involve financial losses. If it were only a question of transferring substantial funds to the United States or Canada this would be today probably still a simple matter. Even such a simple transaction though might involve losses, for you would probably have to sell holdings in Egypt at a time when such holdings are already depressed in value. You may open an account with the Chase National Bank or the

Corn Exchange Bank in New York, I think funds entrusted to them can be considered fairly safe for the time being.

In the long run, however, a simple transfer of holdings to America is not a sufficient safeguard as long as you keep your residence in Egypt. There is little doubt that in an emergency Egypt will follow the example of other countries and compel its residents to withdraw their foreign holdings. Therefore, in order to protect yourself it would be necessary for you to have your American holdings in the form of a trust fund. Though this is a rather complicated and perhaps somewhat expensive form, I believe you ought to give this form serious consideration. If your husband or another member of your wider family could visit America in the near future, he could, I am sure, find a satisfactory form which would "hold water" in an emergency. Nowadays, a trip to America is a simple, enjoyable and surprisingly inexpensive affair.

I fear that all ~~them~~ precautions are incomplete unless you also now secure the right for you and your family to emigrate to America in case you want to do so at some future date. This right you can secure for all practical purposes if your husband comes here now for a visit under the immigration quota. He can return after a fortnight's stay with a re-enter permit which would safeguard him and his family for the future. I would have to tell you more details about this point if you decide that want to give the matter serious consideration.

That is about as much as I can say at present on general grounds, since I do not know your particular situation. Very few of my many friends in Central Europe with whom I talked about

such subjects in 1931, just before I first came - as an immigrant - to America, were willing to go through all the trouble of the precautions mentioned in this letter. Still I would like to believe that now that your part of the world is threatened you will belong to these very few.

Please let me know if you ~~xxxx~~ want more detailed information on any of the points touched upon in this letter, or if I can be of help in any other way. Also, if possible, let me know something about yourself.

Believe me please that in ordinary circumstances I would hesitate to give "advice" without being asked. Nowadays, with so many friends from Europe before my eyes, arriving here almost daily practically destitute, I would go about with an uneasy conscience if I had not written you this letter.

With the very best wishes,

yours sincerely,

(Leo Szilard)

April 18th, 1939

Dear Ben:-

The enclosed Manuscript, I am sorry to say, will appear in the next issue of Physical Review.

Yours,

(Leo Szilard)

Cable Address:
TRUBENIZE NEW YORK

TRUBENIZING PROCESS CORPORATION
350 FIFTH AVENUE
NEW YORK, N. Y.

November 29, 1939.

Dr. Leo Szilard
King's Crown Hotel
420 West 116th St.
New York N.Y.

Dear Leo:

In connection with some funds which I have received for safekeeping from Holland, I have just had occasion to look into the question of joint accounts, and I find that a joint account becomes legally the property of either one of the names in the event of the death of the other.

It occurs to me that you may want to change the status of your account in which my name appears as a joint account. I think it would be best all around if this arrangement were changed. The simplest alternative would be to give a power of attorney instead of having a joint account. You objected to the power of attorney scheme at the time the joint account was formed on the ground that the power of attorney would cease with the death of the giver of the power and that the funds would become tied up in the event of your death. This still holds true but it seems to me that it would involve less complications all around than the joint account. Another point which I would like to submit for your consideration is the advisability of having your brother Bela act in my stead. In that case a joint account would be a perfectly normal and natural thing and would not involve any complications upon the death of either party. My best suggestion, therefore, is for you to withdraw all monies from the existing account of L.Szilard and B.Liebowitz, and open a new joint account in the name of L.Szilard and B.Szilard.

Sincerely yours,

Ben Liebowitz

C

Incorrect

December 4, 1939

Dr. Benjamin Liebowitz
350 Fifth Avenue
New York City

Dear Ben:

Early this year I asked you to loan me $ 2000.- (two thousand dollars) in order to make it possible for me and my associates to rent about 1 gram of radium so that we might carry out some very urgent and important experiments on uranium, which we thought might have some bearing on problems of national defense. I told you at that time that I was confident that I could raise some money for these experiments by putting the matter up to some foundation or possibly some department of the Administration, and that I expected to pay back your loan within six months' time. I have spent most of the sum which you loaned me for the renting of 900 mg of radium for a period of ten months, $ 400.- were spent on freeing Dr. Zinn from his teaching duties at City College, and the rest up to the last cent was spent on apparatus which were urgently needed.

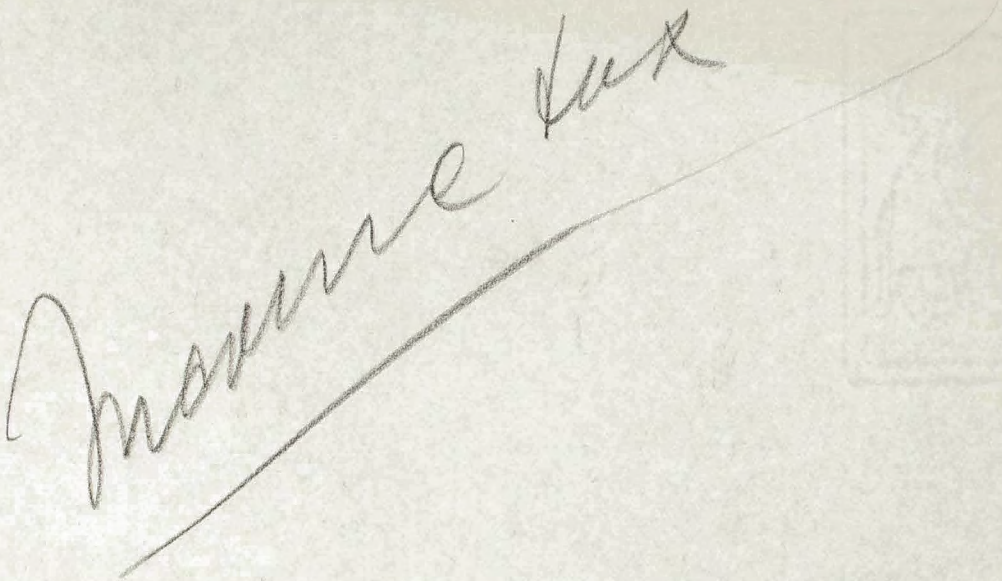
Until recently I had hoped that I should be able to obtain financial support for these experiments and be able to return to you the sum which you loaned me. This proved to be impossible, and I had to return the radium and close down experiments. Under ordinary conditions I would naturally refund your loan from my private earnings. Unfortunately, I have not earned anything during this year, as I

was tied up with this work on uranium. It looks as though I shall not be able to earn anything next year either, especially since I cannot now return to England. In the circumstances, the prospects of my being able to return to you your loan $ 2000.- are very bad, and I am afraid you will have to consider these $ 2000.- as a bad debt.

I am sorry to have to cause you this disappointment.

Yours very sincerely,

Leo Szilard



October 30, 1943

Dr. B. Liebowitz
c/o Trubenizing Process Co.
Empire State Building
New York, New York

Dear Ben:

I am writing to let you know that the lawsuit about which I told you has been settled and that I am in the unencumbered possession of all the rights which previously fell under the agreement concluded with Mr. Adam in 1936. I have asked my patent attorney in Chicago to draw up a document which will assign to you the British and American patents which are specified by number in the agreement that you and I recently concluded. As soon as I receive the document I will send it to you with my notarized signature.

Hope to see you some time over the weekend when I am in New York.

With kind regards,

Yours,

L. Szilard

1) Assignment by L.S to Benjamin Liebowitz of USA Pat. # 2,161,985 British Pat. # 440,023

Corresp. with attorneys relating to above

Great Britain
Assignment
Patent

ASSIGNMENT

AND INDENTURE, made the 24th day of November, 1943, between Leo Szilard of the City of Chicago, State of Illinois, United States of America (hereinafter called the Assignor) of the one part and Benjamin Liebowitz of the City of New Canaan, State of Connecticut, United States of America (hereinafter called the Assignee) of the other part.

WHEREAS the Assignor claims to be the owner of a certain invention and Letters Patent of The United Kingdom of Great Britain, and Northern Ireland and the Isle of Man, hereinafter described and intended to be hereby assigned.

And WHEREAS, the Assignor has agreed with the Assignee for the sale to him, the Assignee, of all the Assignor's right, title, and interest in and to the invention and Letters Patent in The United Kingdom of Great Britain, and Northern Ireland and the Isle of Man, referred to in the schedule hereunder written for the sum hereinafter expressed:

NOW THIS INDENTURE WITNESSETH that in pursuance of said agreement and in consideration of the sum of ten Pounds Stirling (£10.0.0) paid by the Assignee to the Assignor, upon the signing of these presents (the receipt of which sum is hereby acknowledged), the Assignor, as beneficial owner, hereby assigns unto the Assignee and his legal representatives, absolutely all of his right, title and interest in and to the invention and Letters Patent in The United Kingdom of Great Britain, and Northern Ireland and the Isle of Man, referred to in the schedule hereunder written, and the sole and exclusive benefit thereof, and all rights, powers, and emoluments and advantages whatever under or

in respect of such invention and Letters Patent, the Assignor hereby covenenting with the Assignee and his assigns that, not withstanding anything by him the Assignor done, omitted or knowingly suffered the Letters Patent mentioned in the schedule hereunder written is now valid and subsisting.

IN WITNESS WHEREOF, the said parties to this assignment have hereunto set their hands and affixed their seals the day and year first above written.

SCHEDULE HEREINBEFORE REFERRED TO:

Patent No. 440,023, dated December 12, 1935, entitled Improvements in or Relating to the Transmutation of Chemical Elements.

SIGNED, SEALED AND DELIVERED
BY THE SAID LEO SZILARD
IN THE PRESENCE OF:

Leo Szilard

Albert F. Kelley

Lucartha P. Sullivan

SIGNED, SEALED AND DELIVERED
BY THE SAID BENJAMIN LIEBOWITZ
IN THE PRESENCE OF:

_____

_____

_____

Great Britain

AUTHORIZATION

TO THE COMPTROLLER GENERAL OF PATENTS, DESIGNS AND TRADE MARKS:

SIR:

I, the undersigned, Benjamin Liebowitz of the City of New Canaan, State of Connecticut, United States of America, do hereby appoint

of

to act as my agent in connection with the registration of the accompanying Assignment of Letters Patent as follows:

Patent No. 440,023, Dated December 12, 1935, Entitled Improvements in or Relating to the Transmutation of Chemical Elements. And I hereby authorize to sign the Form of Request on my behalf and request that all communications relating thereto may be sent to them at the above address.

Dated the _____ day of _____, 1943.

_____

WITNESSES:

_____

_____

A S S I G N M E N T

WHEREAS, LEO SZILARD, of Chicago, in the County of Cook, and State of Illinois, hereinafter called the Assignor, has invented certain new and useful Improvements in Process of Producing Radio-active Elements, for which Letters Patent of the United States No. 2,161,985 were issued to him on June 13, 1939; and

WHEREAS, BENJAMIN LIEBOWITZ, of New Canaan, Connecticut, hereinafter called the Assignee, is desirous of acquiring the entire right, title, and interest in and to said invention and Letters Patent now vested in the said Assignor, including all rights of action that may have accrued under said Letters Patent; and

WHEREAS, the said Assignor warrants and guarantees that he is the sole owner of all the right, title, and interest in, to and under said invention and Letters Patent; ~~that said Letters Patent are free of lien~~; and that the said Assignor has a good right to make the sale and conveyance herein made:

NOW, THEREFORE, TO ALL WHOM IT MAY CONCERN, Be it known that for and in consideration of the sum of One Dollar ($1.00) by the said Assignee to the said Assignor in hand paid, the receipt of which is hereby acknowledged, the said Assignor has sold, assigned and transferred, and by these presents does sell, assign, and transfer unto the said Assignee, its successors and assigns, the entire right, title, and interest in and to the invention and Letters Patent herein identified, the same to be held and enjoyed by the said Assignee, for the sole and exclusive use and behoof of itself, its successors and assigns, to the full end of the term for which the said Letters Patent are granted, as fully and entirely as the same would have been held and enjoyed by the

said Assignor had this assignment not been made.

For the same consideration, the said Assignor hereby gives and conveys to the said Assignee the right to sue for and recover in its own name, all damages, profits, or other recoverable compensation which may have accrued or to which the Assignor may be entitled by reason of any infringement of said Letters Patent.

IN TESTIMONY WHEREOF, the said Assignor has hereunto set his hand and affixed his seal this 24th day of November 1943.

L. Szilard (SEAL)

STATE OF ILLINOIS)
) ss.
COUNTY OF COOK)

I, _____, a Notary Public in and for the County and State aforesaid, do hereby certify that LEO SZILARD, personally known to me to be the same person whose name is subscribed to the foregoing instrument, appeared before me this day in person and acknowledged that he signed, sealed, and delivered the said instrument as his free and voluntary act for the uses and purposes therein set forth.

IN WITNESS WHEREOF, I have hereunto set my hand and Notarial Seal, this _____ day of _____, 1943.

_____
Notary Public

1155 East 57th Street
Chicago, Illinois
November 24, 1943

Dr. B. Liebowitz
Empire State Building
Fifth Avenue
New York, New York

Dear Ben:

Inclosed I am sending you the assignments which I have signed. There are some signatures needed by you on the assignment of the British patent.

In the American text I have stricken out the sentence that asserts that the patent is free of liens since I am not sure whether or not there might not be an attorney's lien on the American patent. I thought it better not to make inquiries at the present time in order to let sleeping dogs lie.

With respect to the British patent I have to add that this patent is looked after by Claremont, Haynes & Co., Vernon House, Sicilian Avenue, Bloomsbury Square, London, W. C. 1, and it might be simplest to appoint them as your agents.

Apparently there was some misunderstanding and you interpreted my last letter to indicate that I had the intention to come to New York Monday two weeks ago. What I meant was that I hope to see you soon on a Monday, which still holds, but I do not yet know which Monday it will be.

With kind regards,

Yours,

L. Szilard

LS:s
incls.

WILKINSON, HUXLEY, BYRON & KNIGHT
FIRST NATIONAL BANK BUILDING
CHICAGO

A S S I G N M E N T

WHEREAS, LEO SZILARD, of Chicago, in the County of Cook, and State of Illinois, hereinafter called the Assignor, has invented certain new and useful Improvements in Process of Producing Radio-active Elements, for which Letters Patent of the United States No. 2,161,985 were issued to him on June 13, 1939; and

L.S. BL

WHEREAS, BENJAMIN LIEBOWITZ, of ~~New Canaan, Connecticut~~ Lewisboro, Westchester Co., N.Y., hereinafter called the Assignee, is desirous of acquiring the entire right, title, and interest in and to said invention and Letters Patent now vested in the said Assignor, including all rights of action that may have accrued under said Letters Patent; and

L. L. BL

WHEREAS, the said Assignor warrants and guarantees that he is the sole owner of all the right, title, and interest in, to and under said invention and Letters Patent; ~~that said Letters Patent are free of liens~~; and that the said Assignor has a good right to make the sale and conveyance herein made:

NOW, THEREFORE, TO ALL WHOM IT MAY CONCERN, Be it known that for and in consideration of the sum of One Dollar ($1.00) by the said Assignee to the said Assignor in hand paid, the receipt of which is hereby acknowledged, the said Assignor has sold, assigned and transferred, and by these presents does sell, assign, and transfer unto the said Assignee, its successors and assigns, the entire right, title, and interest in and to the invention and Letters Patent herein identified, the same to be held and enjoyed by the said Assignee, for the sole and exclusive use and behoof of itself, its successors and assigns, to the full end of the term for which the said Letters Patent are granted, as fully and entirely as the same would have been held and enjoyed by the

said Assignor had this assignment not been made.

For the same consideration, the said Assignor hereby gives and conveys to the said Assignee the right to sue for and recover in its own name, all damages, profits, or other recoverable compensation which may have accrued or to which the Assignor may be entitled by reason of any infringement of said Letters Patent.

IN TESTIMONY WHEREOF, the said Assignor has hereunto set his hand and affixed his seal this 24th day of November, 1943.

Leo Szilard (SEAL)

STATE OF ILLINOIS)
COUNTY OF COOK) ss.

I, Lucartha P. Sullivan, a Notary Public in and for the County and State aforesaid, do hereby certify that LEO SZILARD, personally known to me to be the same person whose name is subscribed to the foregoing instrument, appeared before me this day in person and acknowledged that he signed, sealed, and delivered the said instrument as his free and voluntary act for the uses and purposes therein set forth.

IN WITNESS WHEREOF, I have hereunto set my hand and Notarial Seal, this 24th day of November, 1943.

Lucartha P. Sullivan
Notary Public

Great Britain

Assignment

Patent

ASSIGNMENT

AND INDENTURE, made the 24th day of November, 1943, between Leo Szilard of the City of Chicago, State of Illinois, United States of America (hereinafter called the Assignor) of the one part and Benjamin Liebowitz of ~~the City of New Canaan, State of Connecticut~~ the Township of Lewisboro, County of Westchester, State of New York, United States of America (hereinafter called the Assignee) of the other part.

L.L.B.L
L.L.B.L

WHEREAS the Assignor claims to be the owner of a certain invention and Letters Patent of The United Kingdom of Great Britain, and Northern Ireland and the Isle of Man, hereinafter described and intended to be hereby assigned.

And WHEREAS, the Assignor has agreed with the Assignee for the sale to him, the Assignee, of all the Assignor's right, title, and interest in and to the invention and Letters Patent in The United Kingdom of Great Britain, and Northern Ireland and the Isle of Man, referred to in the schedule hereunder written for the sum hereinafter expressed:

NOW THIS INDENTURE WITNESSETH that in pursuance of said agreement and in consideration of the sum of ten Pounds Stirling (£10.0.0) paid by the Assignee to the Assignor, upon the signing of these presents (the receipt of which sum is hereby acknowledged), the Assignor, as beneficial owner, hereby assigns unto the Assignee and his legal representatives, absolutely all of his right, title and interest in and to the invention and Letters Patent in The United Kingdom of Great Britain, and Northern Ireland and the Isle of Man, referred to in the schedule hereunder written, and the sole and exclusive benefit thereof, and all rights, powers, and emoluments and advantages whatever under or

in respect of such invention and Letters Patent, the Assignor hereby covenenting with the Assignee and his assigns that, not withstanding anything by him the Assignor done, omitted or knowingly suffered the Letters Patent mentioned in the schedule hereunder written is now valid and subsisting.

IN WITNESS WHEREOF, the said parties to this assignment have hereunto set their hands and affixed their seals the day and year first above written.

SCHEDULE HEREINBEFORE REFERRED TO:

Patent No. 440,023, dated December 12, 1935, entitled Improvements in or Relating to the Transmutation of Chemical Elements.

SIGNED, SEALED AND DELIVERED
BY THE SAID LEO SZILARD
IN THE PRESENCE OF:

A Leo Szilard

B Stuart Riley

C Lucartha P. Sullivan

SIGNED, SEALED AND DELIVERED
BY THE SAID BENJAMIN LIEBOWITZ
IN THE PRESENCE OF:

D Benjamin Liebowitz

E Helen Rose

F Harold Kahn

Great Britain

Assignment

Patent

ASSIGNMENT

AND INDENTURE, made the 24th day of November 1943, between Leo Szilard of the City of Chicago, State of Illinois, United States of America (hereinafter called the Assignor) of the one part and Benjamin Liebowitz of the ~~City of~~ Township of Lewisboro, County of Westchester, State of New York, ~~New Canaan, State of Connecticut~~, United States of America (hereinafter called the Assignee) of the other part.

L.S. BL
L.S. BL

WHEREAS the Assignor claims to be the owner of a certain invention and Letters Patent of The United Kingdom of Great Britain, and Northern Ireland and the Isle of Man, hereinafter described and intended to be hereby assigned.

And WHEREAS, the Assignor has agreed with the Assignee for the sale to him, the Assignee, of all the Assignor's right, title, and interest in and to the invention and Letters Patent in The United Kingdom of Great Britain, and Northern Ireland and the Isle of Man, referred to in the schedule hereunder written for the sum hereinafter expressed:

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in respect of such invention and Letters Patent, the Assignor hereby covenenting with the Assignee and his assigns that, not withstanding anything by him the Assignor done, omitted or knowingly suffered the Letters Patent mentioned in the schedule hereunder written is now valid and subsisting.

IN WITNESS WHEREOF, the said parties to this assignment have hereunto set their hands and affixed their seals the day and year first above written.

SCHEDULE HEREINBEFORE REFERRED TO:

Patent No. 440,023, dated December 12, 1935, entitled Improvements in or Relating to the Transmutation of Chemical Elements.

SIGNED, SEALED AND DELIVERED
BY THE SAID LEO SZILARD
IN THE PRESENCE OF:

Leo Szilard

Lucartha P. Sullivan

SIGNED, SEALED AND DELIVERED
BY THE SAID BENJAMIN LIEBOWITZ
IN THE PRESENCE OF:

Benjamin Liebowitz

Helen Rose

Harold S Kohlenberg

Great Britain

AUTHORIZATION

TO THE COMPTROLLER GENERAL OF PATENTS, DESIGNS AND TRADE MARKS:

SIR:

I, the undersigned, Benjamin Liebowitz of the City of New Canaan, State of Connecticut, United States of America, do hereby appoint G

of H

to act as my agent J in connection with the registration of the accompanying Assignment of Letters Patent as follows:

Patent No. 440,023, Dated December 12, 1935, Entitled Improvements in or Relating to the Transmutation of Chemical Elements. And I hereby authorize K to sign the Form of Request on my behalf and request that all communications relating thereto may be sent to them at the above address.

Dated the _____ day of _____, 1943.

L _____

WITNESSES:

M _____

N _____

BENJAMIN LIEBOWITZ
350 FIFTH AVENUE
NEW YORK, N.Y.

September 20, 1944.

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

Dear Leo:

To keep you informed, I am sending you herewith copy of a letter which I have received from the editor of The Physical Review regarding my paper on "A Calculus of Finite Precision with an Application to Dynamics".

Regards.

Yours,

Ben

CC

First Joliot & Halban effect
Jan 20
fission fragment with Halban
Jan 26 sent to C.R.
28 Jan neutrons measurement excess
and probability of neutron emission
(check)
Kowarski talks to Joliot Halban
reproduction in 8

Febr 9th about this and
interpretation. —
March first spatial distribution
is noticed
next at month Halban leadership

2nd paper in Nature april

Beginning of May worry about
change of p with concentration
some doubt now about homogeneous
nuclear masses. —
Lamping idea Kowarski about
May 15 but thinks elements are too
short difference length
kind of party ready for H.K. to Benin
experiment / Soviet sup reaction of Halban

Effect of reaction in short experiment

1155 East 57th Street
Chicago 37, Illinois
June 28, 1945

Dear Ben:

About one and one-half years ago I sold you a British and American patent for the sum of $2000.00 and I subsequently sent you the assignment papers which were executed by me.

I am now writing to you in order to offer to purchase from you these two patents at the price of $4000.00. If this proposal is accepted by you, please let me know by letter as soon as possible. I understand that you have not filed the assignment papers yet and I therefore suggest that you return these assignment papers to me upon receipt of which I will send you a check for $4,000.00

If my offer is accepted, would you be good enough to state exactly in your reply the numbers of the British and American patent to which this transaction refers so as to avoid any possibility of misunderstanding?

Very sincerely yours,

Leo Szilard

Dr. Benjamin Liebowitz
350 Fifth Avenue
New York, New York

BENJAMIN LIEBOWITZ
350 FIFTH AVENUE
NEW YORK, N.Y.

VIA REGISTERED MAIL

July 2, 1945.

Dear Leo;

I hereby accept the offer contained in your letter of June 28th to purchase for the sum of four thousand dollars ($4,000.) two patents which you sold me in November, 1943 as follows:

U. S. Patent #2,161,985 issued on June 13, 1939 for Improvements in Process of Producing Radioactive Elements, and

British Patent #440,023, dated December 12, 1935, entitled Improvements In Or Relating to the Transmutation of Chemical Elements.

I am sending you herewith two documents dated November 24, 1943 which cover the original assignments of the above-mentioned patents by you to me. The return of these assignments to you is all that is required, I believe, inasmuch as I have never registered these assignments either in the United States or in England.

I shall look forward to receiving your check for $4,000. in due course after you have received the enclosed documents.

Yours,

Benjamin Liebowitz

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

Income Tax

1155 E. 57th St.

July 6, 1945

Dr. Benjamin Liebowitz
c/o Trubenizing Process Corp.
Empire State Building
New York, N. Y.

Dear Ben:

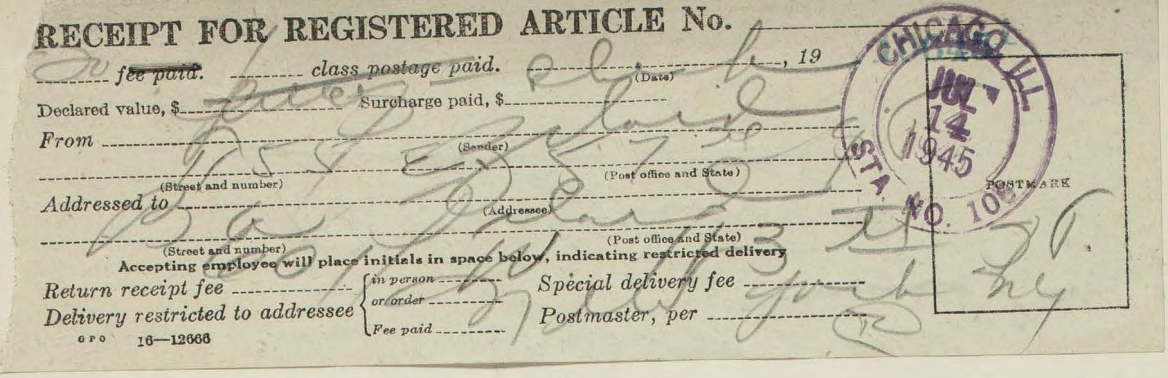
Enclosed is a check for $4,000.00 which I am sending you for the purchase of the two patents which you sold me by your last letter.

Please acknowledge receipt of this check.

Sincerely,

LS:jjp
enc.

Leo Szilard



RECEIPT FOR REGISTERED ARTICLE No. _____

_____ fee paid. _____ class postage paid. $_____, 19 (Date)

Declared value, $_____ Surcharge paid, $_____

From _____ (Sender)

_____ (Street and number) (Post office and State)

Addressed to _____ (Addressee)

_____ (Street and number) (Post office and State)

Accepting employee will place initials in space below, indicating restricted delivery

Return receipt fee _____ Special delivery fee _____

Delivery restricted to addressee { in person _____ / or order _____ / Fee paid _____ } Postmaster, per _____

GPO 16—12666

CHICAGO ILL JUL 14 1945 STA NO. 10 POSTMARK

Income Tax

July 13, 1945

Dear Ben,

I am enclosing a check for $312 corresponding to $12 per week for 26 weeks for the first half of 1945 in order to take care of my share towards our father's living expenses. In the circumstances you have to consider yourself as his main support for the above period of time.

Sincerely,

P.S.--I am returning your letter; there seems to be something wrong with your arithmetics in it. Please acknowledge the receipt of the enclosed check.

BENJAMIN LIEBOWITZ
350 FIFTH AVENUE
NEW YORK, N.Y.

August 29, 1945.

Dear Leo,

I must apologize for not having written you sooner to acknowledge your letter of August 20 and the check for $4000. which accompanied it. This check represents payment on the repurchase by you from me of the following patents, which you sold me in November 1943:

U.S. Patent No. 2,161,985

British Patent No. 440,023

Kindest regards.

Sincerely,

Ben Liebowitz

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

Looking forward to seeing you soon!

CC

BENJAMIN LIEBOWITZ
350 FIFTH AVENUE
NEW YORK, N.Y.

September 27, 1946.

Dr. Leo Szilard
Professor of Bio-Physics
University of Chicago
Chicago, Illinois.

Dear Leo:

This is to remind you that I am sailing for England on either October 17 or November 6, depending on steamer accommodations.

I would like you to consider the possibility of making a deal with Trubenised Ltd. for handling your liquid-liquid separation invention over there. The first thing to do is to file a patent application, and if you wish us to do so we can take care of the whole matter while I am in England. We also have to talk about terms on which we can do business. Preferably all of this should be done in a personal discussion. Please let me hear from you promptly.

Yours
BL
Ben

P.S. Unless you have objections to it, the details of design will be handled by Bihaly.

C

1155 E. 57th Street
Chicago, Illinois
September 30, 1946

Dear Ben:

Thanks for your letter of September 27. As a matter of principle I shall be very pleased to enter into a business arrangement with Trubenised Ltd. Would it not be best if you jotted down a few notes of what kind of business arrangements you wanted to make with me and then call me over the telephone. I would then give it immediate thought and could call you back the next day. After that, if necessary, we could meet in New York to iron out the details.

I am anxious to move with this matter rather fast and not delay things too much for the sake of an ultimately very large profit.

You may reach me during the day over the telephone through the University, Midway 0800, Extension 720. If you can't get me there, Miss Nissenbaum at Ext. 729, will probably be able to make a guess as to how I can be reached on the campus. Wednesday night and Thursday night I am spending at the Quadrangle Club, Hyde Park 8601, and from Friday night on I am back at Dr. Weiss' apartment, where you can reach me at Midway 0545.

Yours,

Leo Szilard

Mr. Benjamin Liebowitz
350 Fifth Avenue
New York, New York

TRUBENIZING PROCESS CORPORATION
350 FIFTH AVENUE
NEW YORK 1, N. Y.

AIRMAIL

October 3, 1946.

Dear Leo,

First let me say that the urgency for making decisions on your invention has been lessened to a slight degree by the fact that I am sailing on November 6 instead of October 17.

I did not 'phone you because there are so many points that require mutual thinking that I thought it better to write you about them, so as to give you an opportunity to think about the problems before I telephone you.

Much of what I say here has been stimulated by my thinking on the commercial problems surrounding my loom invention. There is enough parallelism in the two instances to suggest that some of the difficulties which I face in connection with the loom must be faced by you also, although on a greatly reduced scale.

The first aspect concerns the reverberations of development in England upon the American rights. Trubenised Ltd. would, of course, file the necessary patent applications in England immediately and would proceed with the design and construction of the first machine. We would have to deal with some big important company, however, in having this machine tried out, and, on the assumption that the company in question has the right kind of personnel, there is a reasonable chance that subsidiary applications might be filed by them not only in England but also in the U.S.A. There is, therefore, the question of possible "encirclement", which is only a minor danger to your invention but a major one to mine. In my case, to overcome this difficulty, I may have to give the English company which develops it some share of the American rights. In your case the danger is not only a minor one but is further minimized by the fact that both Bihaly and I are competent inventors and that we might very well file some subsidiary applications in England and could thereafter make any reasonable arrangement with you concerning the American rights.* This is a point to which you will have to give some thought.

The next question is: What share in the English profits should be yours? I do not think either you or I have any exaggerated notions about the equities of an inventor whose inventions are developed by others with little or no subsequent effort on the part of the inventor; in those cases where the inventor receives a very big slice of the profits, the inventor himself is con-

* i.e., your rights in Bihaly's improvements + mine.

tinuously associated with the project. This is not what you want (it is also what I do not want in the case of the loom). It is very difficult, nevertheless, to arrive at a sensible figure for the inventor's share in the profits. I think that 25% would be a reasonable amount, but I do not know how this will strike you. For your guidance, let me say that, as you know, I receive close to 50% of the Trubenizing profits, but I have been running the company all these years.

The third point on which I would like you to give some thought is whether or not you want some cash payment for the English rights; also what sort of protection you ought to have against our failure to achieve a minimum of financial results to you in the course of a reasonable length of time.

On the matter of cash payment, it would be embarrassing because Trubenised Ltd. would have to get permission from the Bank of England in order to make any transfers to you; moreover, such payments are somewhat embarrassing to us on other grounds which I won't attempt to explain here. On the matter of protection to you, I would suggest that if, in the third year from the date of our agreement, we fail to give you a return of £1000. and in the fourth year a return of £2000. then you will have the right to re-capture your equities on payment of, let us say, all the costs we incurred in connection with the filing and issuance of any patents.

Another point to be considered is the rights on the European Continent. Although there is nothing to be done about those rights at the present moment, nevertheless in a few years' time those rights may be important, and, as a matter of convenience and administration, those rights could properly be assigned to us also in return for an appropriate quid pro quo. A particularly knotty point here is Russia.

Whatever points may be settled or unsettled, one thing we can do without any agreement and that is to make a search in England and have a patent application prepared for you. The cost of the search can be buried so as to be just another item of expense. The cost of filing a patent application, however, is a "capital expenditure" and is not deductible as an expense. If you finally decided not to make a deal with us on the British rights we would then want you to pay for the cost of this British patent application as it appears on our books, but such cost would be much lower there than here. If, therefore, you want to take advantage of this, it will be necessary to have everything in my hands needed for the making of the search and the filing of the patent application.

I would appreciate it if you would acknowledge this letter promptly and advise when you think you could come to New York. I could, of course, telephone you in the interim, as you suggest, but I don't think we will accomplish much that way.

Yours

Ben

C

BENJAMIN LIEBOWITZ
350 FIFTH AVENUE
NEW YORK, N.Y.

October 14, 1946.

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

Dear Leo, Re Liquid-Liquid Separation.

In addition to the photostats I have also received your letter of October 9. I have had an opportunity now to study the whole matter and wish to report as follows.

Your scheme, as disclosed, appears to be inoperative because the entering heavy solvent must pass through the layer of light solvent in the very region where the light solvent is being drawn off. In other words, it seems that after the solution process for which the system is intended has been performed, you will mix the two solvents at the very point of drawing off the separated lighter solvent. In addition, your system, as disclosed, appears to be unworkable from a practical standpoint because, in order to control the flow of the solvents in and out of the system by means of pumps and not by the centrifugal forces, it will be necessary to have the entire system filled with liquids from the point where the liquids enter to the point where the liquids leave; your baffle 20 of Fig. 1, e.g., would not prevent mixing, nor would your rotating fins 15 and 18 of Fig. 1 prevent such mixing, and packing such joints is out of the question. Finally, your system, as disclosed, is complicated beyond all bounds of practicability.

All of these disadvantages can be corrected as shown in Fig. 1 attached hereto. First of all, please note that the outer stationary drum or casing is completely eliminated. The system comprises merely the two concentric drums. As I have shown it, the lighter solvent enters through a gland at the extreme lefthand end of the shaft, and proceeds axially through a bore in the shaft to the clearance space between the flange of the inner drum and the flange of the outer drum; from there the light solvent proceeds radially in this clearance space to its appropriate layer in the annulus between the two drums. A second gland is provided which rides on a hub extension of the flange of the outer drum; the heavier solvent leaves the annulus through a hole close to the periphery of the flange of the outer drum, then travels radially inward through passages in

BENJAMIN LIEBOWITZ
350 FIFTH AVENUE
NEW YORK, N.Y.

this flange, then travels longitudinally through a connecting passages in this flange and then out through said gland. All of this is clearly shown on the drawing, which shows half the structure as indicated. At the right end the situation is identical with that shown at the left end except for the reversal of the arrows indicating the direction of liquid flow (and also except for the driving pulleys, of course). It will be noted that there is no mixing of the solvents at any stage of the process corresponding to the situation which you have in your original layout. In addition, it will be noted that great simplification has been effected in the design as a whole.

The drawing is purely diagrammatic and gives no indication as to actual sizes, or even as to actual structures. Nevertheless, there are a few mechanical points to which I wish to call your attention. I have shown separate bearings for the inner drum and for the outer drum, each held in an independent support mounted on the base. My reason for doing this is to enable adjustment of concentricity. It seems to me that it might be advisable to put into the system a predetermined amount of eccentricity in order to facilitate the local turbulence in the neighborhood of the interface between the two liquids. For this purpose I have also indicated a clearance between the shaft and the bore of the hub of the flange of the outer drum. This clearance needs to be closed with a stuffing box, as I have indicated. The stuffing box has to be of an appropriate design for this purpose.

Through this same stuffing box, moreover, by suitably designing it, the lighter solvent can be made to enter, i.e., the stuffing box can be made to function as a gland for entry of the lighter solvent, in addition to functioning as a stuffing box.

Further details I think will be clear from my sketch without additional description.

I come now to the main point of my letter. Suppose that the design as such is made as perfect and as free from disadvantages as it can conceivably be made; will it still function as you intended, viz., as a highly efficient and very rapid method of liquid-liquid separation? There are very grave doubts in my mind that it will so function.

BENJAMIN LIEBOWITZ
350 FIFTH AVENUE
NEW YORK, N.Y.

Your whole scheme depends on having turbulence locally, i.e. in the neighborhood of the interface, and at the same time preserving separation of the liquids as a whole. At best this is going to require a relatively thick layer of both solvents. This means that you will still have to depend on diffusion for transfer from the layers well removed from the interface. In short, the process, if workable, will be inherently slow.

The first real glimpse I had of your scheme was during the course of a conversation when you disclosed it to Dr. Rosenstein. At that time already I foresaw this possibility and immediately proposed a different scheme which would consist first of mixing the two solvents together and then separating them centrifugally. Both you and Dr. Rosenstein rejected this other scheme out of hand with a promptness that astonished me. I find myself now reverting back to it because it seems to me inherently faster and better in every way.

I have indicated this scheme in photostat of Fig. 2 attached hereto. It will be noted that along with the elimination of the interface or meniscus in the first stage, I have also eliminated the counterflow and have both solvents entering together (or separately if desired) right to the mixing stage. In the mixing stage the annulus between the drums is to be as small as possible; I intend almost literally to "grind" the two solvents together; this process of mixing can be carried so far as to be called emulsifying, although the components must still be separable by the centrifuge afterwards. In thus intimately commingling the two solvents, far more rapid transfer of the substance to be transferred is effected; the areas of contact between the two fluids can be made a maximum and still leave the two fluids centrifugally separable; the areas of contact will thus be immensely greater than in your meniscus scheme.

It will be understood that the end structures shown in Figs. 2 and 3 are substantially the same as that shown in Fig. 1. In order to achieve the maximum of mixing of the two fluids in a minimum of time, the speed differential between the inner drum and the outer drum should be as large as feasible for this purpose; on the other hand, in order to achieve the subsequent separation in the most rapid manner and to a most complete extent, a minimum of turbulence is wanted in the separating stage. Offhand, I see no difficulty

BENJAMIN LIEBOWITZ
350 FIFTH AVENUE
NEW YORK, N.Y.

in reaching a decent compromise between these two opposing demands. Should such a difficulty arise, it can be overcome in a manner which I have indicated in Fig. 2a. In this figure the tapered inner drum is surrounded by another shell which is attached to the flange carrying the outer drum and hence rotates at the same speed as the outer drum. Both liquids are now drawn off through the hub of the flange of the outer drum as indicated in Fig. 2a. I mention this point simply to indicate that there is no inherent difficulty in obtaining centrifugal separation of the two fluids following the intimate mixing in the first stage.

I shall not attempt to cover or even to indicate any of the multifarious modifications of which this system is capable, except for the obvious modification shown in Fig. 3 in which, in the structural forming of the separating stage, both the inner and the outer drums are tapered, whereas in Fig. 2 only the inner drum is tapered. Perhaps no taper is needed at all, i.e., the transition from the mixing to the separating stage may conceivably be made quite abrupt. On this point I am not clear, although it seems to me that the tapered structure shown is preferable.

Fig. 4, attached, is merely for the purpose of indicating that a certain amount of eccentricity between the two drums may be desirable in order to facilitate the mixing in the mixing stage. This eccentricity will be very small because the clearances themselves are very small. Suppose, e.g., that you made the clearance between the two drums some .005 or .010 inches; the eccentricity might be .001 to .003 inches, e.g.; this small eccentricity would not introduce any difficulty in the separating stage, so far as I can see.

Your early comments will be appreciated.

I note from your letter that you could spend Sunday November 3 with me. Fortunately from this standpoint, our sailing has been postponed to November 14. A matter of a few days difference is, therefore, not important. However, the whole aspect of the situation has been changed so radically as a result of my analysis and re-synthesis, that earlier discussion would be very desirable.

Yours
Ben Liebowitz

c

BENJAMIN LIEBOWITZ
350 FIFTH AVENUE
NEW YORK, N.Y.

P.S. I have had photostatic copies made of your specification and drawings and am returning your originals to you herewith.

1155 East 57 Street
Chicago 37, Illinois
October 19, 1946

Dear Ben:

I was very glad to see from your letter of October 14 that you are now giving some thought to the technical problems involved in liquid extraction. I shall be in New York and at your disposal Monday the 28th ~~&~~ Tuesday the 29th and Wednesday the 30th until lunch time. I have to leave after lunch for Washington. How would it be to meet Monday morning at your office after 10 am?

To the first paragraph of your letter, which contains criticisms of my drawings, I have the following remarks to make. You may be right that it is not very good to let the heavy solvent pass through the layer of the light solvent too close to the point where the light solvent is being drawn off. Perhaps a longer stretch ought to be interposed between these two points.

I disagree with your statement that the entire system ought to be filled with liquid from the point where the liquids enter to the point where the liquids leave. In my scheme the pumps feed in the liquids only slowly, and the level of the liquids is at all times determined by the overflows. The gas pressure above the free liquid levels ought to be the same, i.e., atmospheric pressure. The specifications which I sent you is probably deficient in not emphasizing this point

more strongly.

I would like to talk to you about the question whether the method which I use for removing the liquids permits them to keep them apart after they leave the rotating system or whether mixing would occur in the casing.

The modification which you describe in your Figure 1 may have some points in its favor. The manner in which you introduce and remove the liquids, however, cannot be accepted without change. It contains no automatic guarantee (such as is contained in my mechanism) that the meniscus separating the lighter solvent from the heavier solvent will remain in the place where you have drawn it, that is, within the annular gap between the two rotating cylinders.

Toward the middle of your page 2 you mention the possibility of having a predetermined amount of eccentricity in the system in order to facilitate the local turbulence. I am in disagreement on this point, and I am also in disagreement with the first paragraph on page 3 of your letter. The rest of your letter is based, it seems to me, on a misunderstanding of the essential feature of the liquid extraction process, which is based on the counter-current system. Let me try to focus your attention on the crucial point. Suppose you have two solvents, for instance, ether and water, and have a substance which is soluble in both. It is our purpose now to transfer this substance from the water to the ether by means of liquid extraction. Let us assume that in equilibrium, when you have, an equal volumes of water and ether,

45 percent of the substance will be in the water and 55 percent of the substance will be in the ether. If you do what you propose to do in the last part of your letter, namely, mix ~~intimately~~ intimately the water and the ether and then separate the two, all you would achieve would be to have an equilibrium ~~distribution~~ distribution, that is, you would still have 45 percent of the substance in the water. In contrast hereto, if you send the water containing the substance in solution and pure ether through my gadget, in counter current fashion, you will come out with practically pure water and practically all of the substance which was originally contained in the water ~~has contained in~~ transferred to the ether leaving the gadget.

I still think that, apart from mechanical details, which it will be great pleasure to discuss with you in New York, my original scheme is a good one and will work in a satisfactory manner. I wish I were equally convinced of its novelty.

Yours,

Leo Szilard

BENJAMIN LIEBOWITZ
350 FIFTH AVENUE
NEW YORK, N.Y.

REGISTERED

October 21, 1946.

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

Dear Leo,

I was glad to get your letter of October 19.

So far as I know at present it will be very convenient for me to meet you at my office on Monday morning, October 28 at, say, 10:30 or 11 A.M. We could continue our discussions thru the lunch period.

You are probably right in objecting to my statement that the entire system must be filled with liquid in order to control the flow of solvents through it. But it is necessary, for practical success, to simplify the system as much as possible, and the scheme I have shown in my Fig. 1 which I sent you accomplishes that simplification, I believe, and certainly does not impair control.

It appears, furthermore, imperative to avoid mixing the two solvents at or near the point of exit of the light solvent. The difficulties involved in this mixing could be overcome, as you say, by providing a sufficiently long distance between the point of entry of the heavy solvent and the point of exit of the light one. But this would involve a serious uncertainty and would also involve unnecessary waste of length of apparatus. I am unable to see any difficulty in controlling the position of the meniscus in the design of my Fig. 1. However, either I am missing something, or you are. This had better be left to a personal discussion.

We are also in disagreement about the first paragraph, p.3, of my letter, in which I point out that in the last analysis you must depend on diffusion in the absence of any means for bringing different portions of each of the solvents into contact with each other at the meniscus. This point also had better be left to our personal discussions.

As to my mixing scheme, I do not believe that I misunderstood the extraction process as completely as you have indicated.

Consider your example of a substance which is dissolved in water and which is to be removed therefrom by ether extraction. It is perfectly true that if I pass equal volumes

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of the two solvents through the apparatus, I would come out with an equilibrium distribution of the solute between the two solvents. But there is nothing in the scheme to prevent my passing, let us say, 100 volumes or 1000 volumes of the ether through the apparatus for each volume of water. Despite this large excess of extractor over "extractee" (pardon my invention of new words to fit the situation), it still seems to me quite definite that the mixing scheme will be inherently faster than the meniscus scheme.

Having such a large excess of the extractor solvent corresponds to nothing more than present practice, as I understand it. It is quite true, however, that a counterflow scheme would have the advantage of requiring considerably less excess of the extractor solvent in the process, so the natural thing to do is to try to combine the mixing and the counterflow schemes. It appears to me possible to do so.

Suppose, for example, that the drums were made symmetrical with the mixing stage in the centerm more or less as indicated in the accompanying figure, which I have here labeled 5. Although it may not be necessary in all cases, for general utility I propose to bring the lighter solvent in near one edge, say the left-hand edge of the mixing stage, and the heavier solvent near the other edge of the mixing stage. I propose, furthermore, to provide separating stages at each end of the apparatus and to provide means for exit of both solvents at both ends. Let us assume again that the light solvent enters from the left and passes out at the right; and let us assume the opposite flow for the heavy solvent. Whatever of the heavy solvent reaches the left end of the separating stage will be drawn off and purified to at least the same extent as in the meniscus scheme; however, there will also be some of the heavy solvent traveling to the right before it has a chance to be purified. This unpurified heavy solvent is drawn off at the rate at which it accumulutes and is re-circulated back into the main stream of entering heavy solvent. Similarly, some of the light solvent entering at the left edge of the separating stage will migrate to the left. This will not have had a chance to do any extracting and will be substantially pure; it is therefore drawn off and re-circulated with the main stream of entering light solvent. Of course, it will be necessary to do quite a bit of "cutting and trying" in order to determine proper rates of flow at the various entering and leaving points, but such cutting and trying is necessary in any case.

BENJAMIN LIEBOWITZ
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I have not been able to give this combination of schemes sufficient thought to satisfy myself as to its workability. All I can say is that at present it seems to be workable. As you have pointed out, however, the question of novelty is a fundamental one which we must face. It sometimes happens, however, that by asking oneself "What is wrong with this obvious scheme - why isn't it used?" one discovers the difficulty in the obvious method and works around till one succeeds in circumventing the difficulties and by that means finds the element of novelty.

For instance, over 25 years ago I invented a brake scheme which on further reflection I was convinced must be old; I therefore searched for the weakness in the scheme, found it and overcame it, and succeeded in obtaining a series of good patents, despite the fact that the obvious scheme from which I started turned out to be at least 50 years old at the time.

So, by batting this liquid-liquid separation idea back and forth between us we may actually succeed in finding a practical workable scheme with the elements of novelty in it.

I am looking forward to seeing you next Monday.

Yours

Ben Liebowitz

C P.S. After making the enclosed drawing it occurred to me that the ultimate scheme might conceivably be one which combines the meniscus method and the mixing method. The taperings which I have shown could be made more gradual and, of course, they would always be rounded off, at least to some extent. The region of close approach of the two drums, i.e., the mixing stage, would then be relatively short. Any backflow of either solvent that failed to get through the mixing stage would be separated out and rejoin the solvent migrating toward the mixing stage. There might still be a certain amount of backflow that would not be caught in this way and hence would accumulate on the respective sides. Such residual backflow could be removed through the valves x and y as shown in the drawing, as before; the main difference being that the amount of backflow would be reduced to a minimum by proper design. To a considerable extent Fig. 5 already shows this combination of schemes.

BENJAMIN LIEBOWITZ
350 FIFTH AVENUE
NEW YORK, N.Y.

PS-2. Driving to its logical conclusion the concept of combining your scheme of counterflowing meniscus with my scheme of mixing and separating, one arrives finally at a picture in which a plurality of mixing stages are used in series with one another and the axial length of each mixing stage is reduced, mathematically speaking, to a line, i.e., a circle perpendicular to the shaft where the inner and outer drums have the minimum separation. Stated in physical terms, as one illustration, we might make the inner drum corrugated, the corrugations being in the form of circular ribs at right angles to the axis. The corrugations should preferably be rather shallow and the distance from the highest point of one corrugation to the next may be fairly long, e.g., let us think of our corrugations as being something like 1/4" high and the spacing between the highest points of the corrugation, say, 2 inches. In between the corrugations there would be a counterflow following more or less your meniscus scheme. Near the ~~biggest~~ "hills" of the corrugations there would be mixing, with backflow, but the lighter solvent which flowed backwards from its main course would be separated from the heavy solvent in the trough of the corrugations, would therefore be caught up in the general stream of the lighter solvent, and hence would make ~~no~~ another attempt at passing the mixing stage. This struggle to get through the mixing stage would occur at each mixing stage, i.e., at each of the regions of closest approach of the inner and outer drums.

The scheme might be described as promoting axial mixing instead of trying to hinder it. Of course, at the ends of the drum one would have clearcut separating stages, as before. Finally, with the possibility in mind of using a large number of mixing stages in series in this way, the intimacy of mixing at each stage need not be so great. This means that the separation at closest approach, instead of being of the order of a few thousandths of an inch, may be of the order of a few hundredths of an inch, or conceivably, even bigger. In fact, one might make the differences in distance between the two drums, as one proceeds axially along the drums, much smaller than anything I had hitherto contemplated, so that there is a minimum of backflow at each "mixing stage"; this will also give a minimum of mixings but a large number of repetitions of these mixings in the course of the axial travel of the liquids would make up for the

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NEW YORK, N.Y.

lessened degree of mixing at each stage. Structurally this scheme begins to resemble somewhat one of the schemes which you proposed for minimizing axial mixing but is much ~~smaller~~ smaller and functions in the opposite way, i.e., to promote axial mixing. There should be no difficulty in effecting final separation in the clearcut separating stages at the ends despite any backflow which might still exist at the ends. If there is, one can compensate by drawing off the fluid that flows backwards at these end stages, as I have indicated in Fig. 5.

BL

BENJAMIN LIEBOWITZ
350 FIFTH AVENUE
NEW YORK, N.Y.

November 8, 1946.

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

Dear Leo: Re Liquid-Liquid Separation

To my great regret I have been compelled to do some work on the liquid-liquid separation. The purpose of this note is to give you results of some of my thinking.

In the first place, I am glad to be able to say that I can make a virtue of necessity by pointing out that, in the embodiment shown in your figures, the heavy solvent must pass through the light solvent and thereby, during that brief period, gives a mixing action which, of course, is really highly desirable (!!). This provides what we have been seeking, viz., a basis for a broad claim founded on your original disclosure. The fact that in modifying the disclosure we may have the point of entry of the heavy solvent a little farther from the point of exit of the light solvent does not in any way affect the situation.

I have been giving a good deal of thought as to how to revise your Fig. 1 so as to retain its essential features, remove elements of doubtful workability, and make it crystal clear. I am enclosing herewith a rough sketch showing the essentials of revised Fig. 1 as I think it should be made. Your prompt comments will be greatly appreciated.

I also have worked out a little theory that is necessary for our complete understanding of the various pressures, etc. and am sending you a copy of it in longhand herewith.

Yours,

BL

Ben

C

P. S. Please return the enclosed drawing.

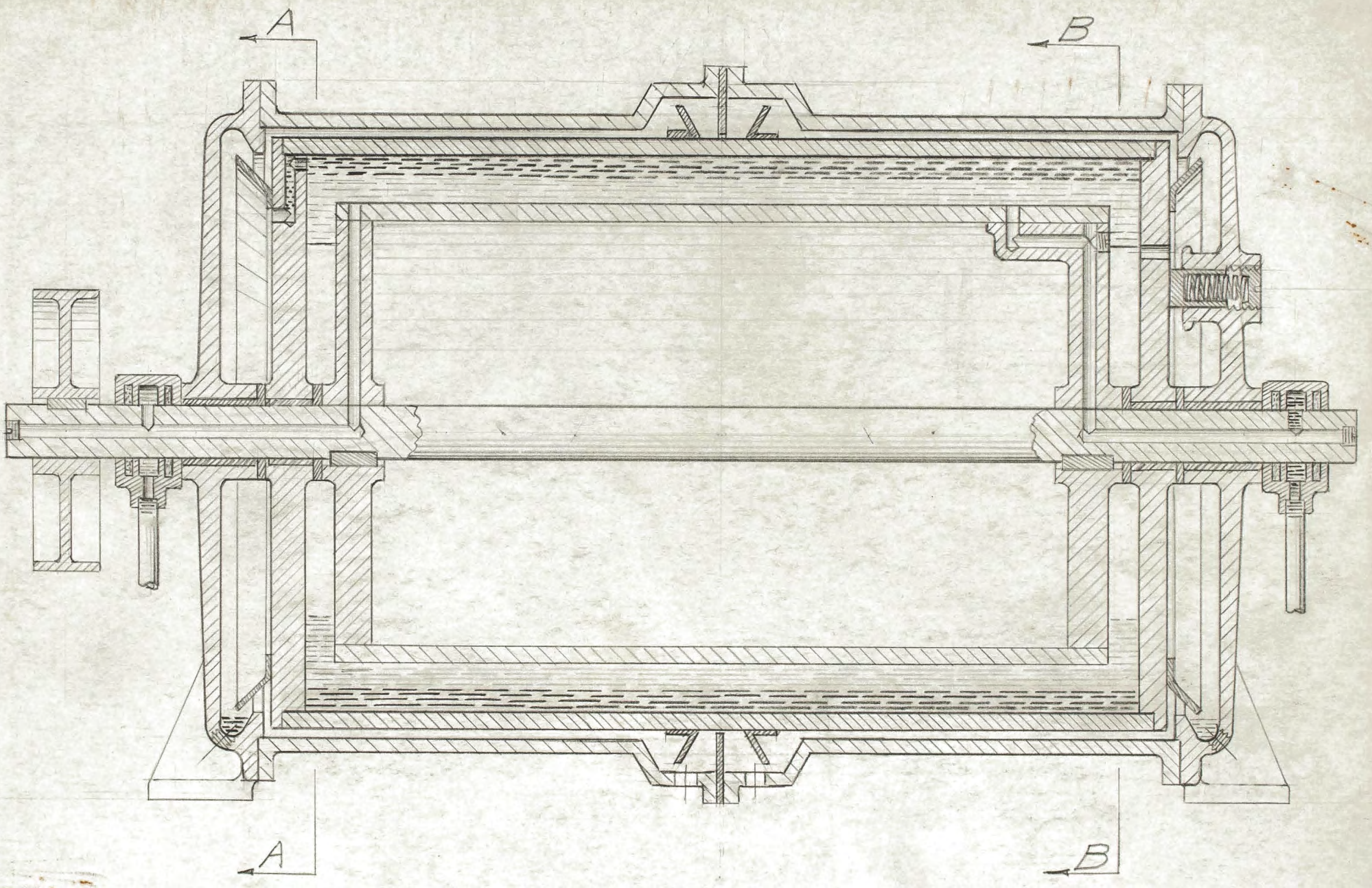
BENJAMIN LIEBOWITZ
350 FIFTH AVENUE
NEW YORK, N.Y.

November 9, 1946.

P.S. You will note that the theory indicates very clearly that the most advantageous position for the exhaust ports is as near to the center as possible. After I had derived this result the patents from Striker came in. It is important to look them over for general information. They indicate quite clearly that the point of efflux of the liquids should be close to the center.

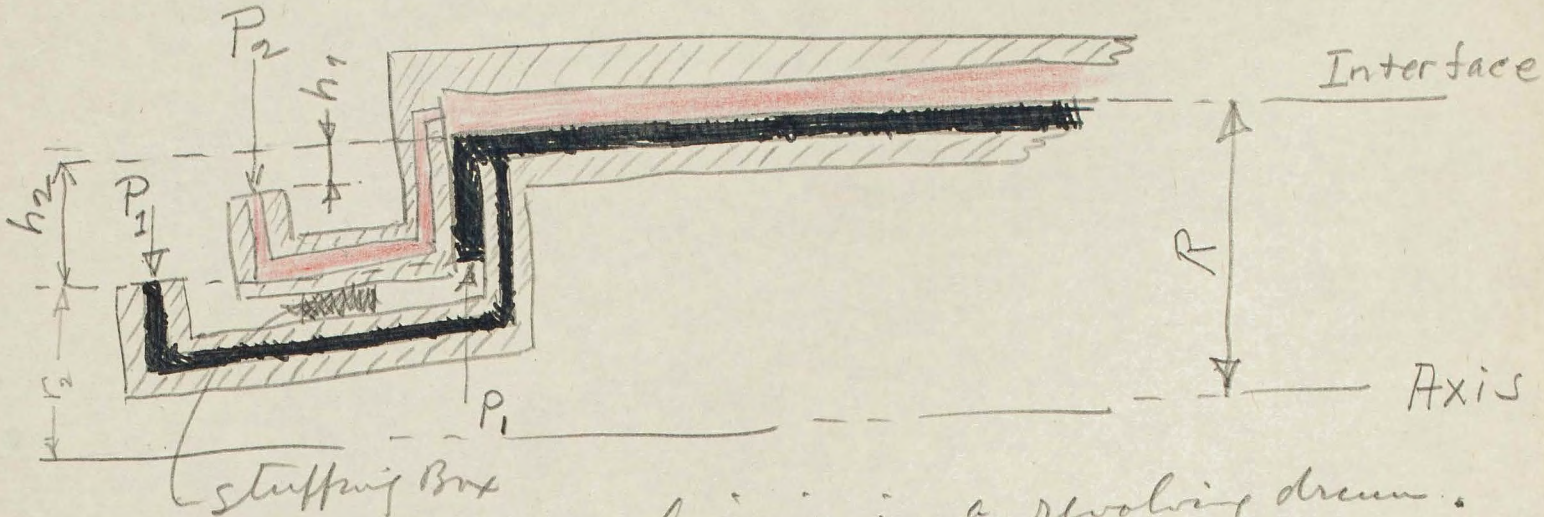
Rosenstein is having dinner with us on Sunday and I will have an opportunity to discuss the situation with him then.

N.B. Prior art shows importance of being able to adjust orifice levels.



11-8-46
A. Moses

Nov. 7, 1946



Consider a liquid in a revolving drum. ~~which has a free pressure P_0 on a free~~ Let the liquid have a free surface at a distance r_0 from the axis and let there be a gas under pressure P_0 acting on this free surface. Let ω = angular velocity, ρ = density, g = acc. of gravity. Then the pressure P_r in the liquid at a distance r from the axis ($r > r_0$) is given by

$$P_r = P_0 + \int_{r_0}^{r} \frac{\rho}{g} \omega^2 r \, dr.$$

ρ does not depend on r, at least not appreciably, and altho ω does, (i.e., in a centrifuge with differential speed) we may take some average $\bar{\omega}$ and without material error, since ω will vary little with r. Hence, to sufficient accuracy for our purpose

$$P_r = P_0 + \frac{\rho \bar{\omega}^2}{2g} (r^2 - r_0^2)$$

Putting $r_0 = r - h$

$$P_r = P_0 + \frac{\rho \bar{\omega}^2}{2g}\left(2rh - h^2\right)$$

If there are two unmixed liquids in the drum in contact at an interface at a distance R from the center, then the condition for equilibrium requires that P_R, the pressure at the interface, be the same for both liquids. Using subscript 1 for the lighter liquid, 2 for the heavier, we have

$$P_1 + \frac{\rho_1 \omega_1^2}{2g}\left(2Rh_1 - h_1^2\right) = P_2 + \frac{\rho_2 \omega_2^2}{2g}\left(2Rh_2 - h_2^2\right) \qquad A.$$

This is the general formula, subject to no restrictions except that the angular velocity shall not vary rapidly as a function of r, and ~~that~~ likewise for the density ρ. It is not assumed that ρ is constant along the drum. In the case of a liquid-liquid process in centerplation, ρ_i will be different at the two ends, and if this change in ρ is substantial, two formulae A will be required, one for each end.

Case 1. Let $P_1 = P_2$ & let $h_i << R$

Then $\rho_1 \omega_1^2 h_1 = \rho_2 \omega_2^2 h_2$

Further, if the difference between ω_1 & ω_2 is negligibly small,

$$\frac{h_1}{h_2} = \frac{\rho_2}{\rho_1}$$

Hence, for small heights h_i of free surface above interface, the equilibrium heights vary linearly as the densities

---

Case 2. Let $\rho_1 = \rho_2$, and let $h_1 = R$, i.e., let the free surface of the light liquid be on the axis.

Then $$\rho_1 \omega_1^2 R^2 = \rho_2 \omega_2^2 (2Rh_2 - h_2^2)$$

$$\therefore \quad h_2^2 - 2Rh_2 + \frac{\rho_1 \omega_1^2}{\rho_2 \omega_2^2} R^2 = 0$$

$$h_2 = R\left(1 \pm \sqrt{1 - \frac{\rho_1 \omega_1^2}{\rho_2 \omega_2^2}}\right)$$

If we put $\rho_1 \omega_1^2 = \rho_2 \omega_2^2 - \Delta\rho\omega$, this becomes

$$h_2 = R\left(1 - \sqrt{\frac{\Delta\rho\omega}{\rho_2 \omega_2}}\right)$$

Finally, if the difference in angular velocities is small, this becomes

$$h_2 = R\left(1 - \sqrt{\frac{\rho_2 - \rho_1}{\rho_2}}\right) \qquad \text{for } h_1 = R$$

or $$h_1 - h_2 = \sqrt{\frac{\rho_2 - \rho_1}{\rho_2}} \cdot R$$

But for case 1 we found $h_1 = h_2 \frac{\rho_2}{\rho_1}$ $\therefore$ $h_1 - h_2 = h_2\left(\frac{\rho_2}{\rho_1} - 1\right)$

or $$h_1 - h_2 = \frac{\rho_2 - \rho_1}{\rho_1} h_2$$

I.e, for small heights, the difference in height varies linearly with the density difference, whereas for maximum height, the difference in height varies only as the square root of the density.

Cable Address:
TRUBENIZE NEW YORK

TRUBENIZING PROCESS CORPORATION
350 FIFTH AVENUE
NEW YORK 1, N. Y.

December 11, 1946.

Professor Leo Szilard
University of Chicago
Chicago, Illinois.

Dear Dr. Szilard:

In accordance with instructions from Mr. Liebowitz (before he left), I am sending you herewith copy of patent No. 2,022,205 to Gustav A. Kramer.

Yours very truly

Evelyn Cramer

Evelyn Cramer

CC

Nov. 26, 1935. G. A. KRAMER 2,022,205

APPARATUS FOR THE TREATMENT OF IMMISCIBLE LIQUIDS

Original Filed July 20, 1931 2 Sheets-Sheet 1

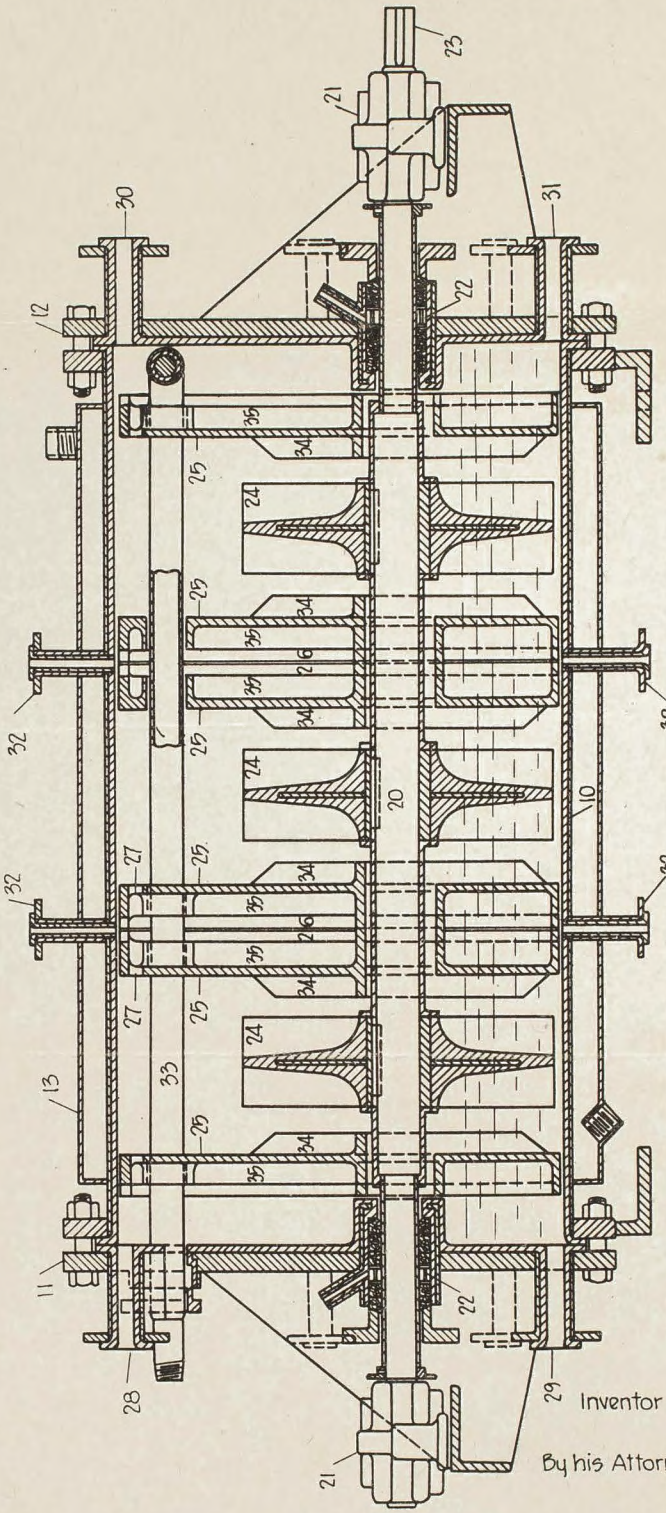


FIG. 1

Inventor: Gustav A. Kramer

By his Attorney

Nov. 26, 1935. G. A. KRAMER 2,022,205

APPARATUS FOR THE TREATMENT OF IMMISCIBLE LIQUIDS

Original Filed July 20, 1931 2 Sheets-Sheet 2

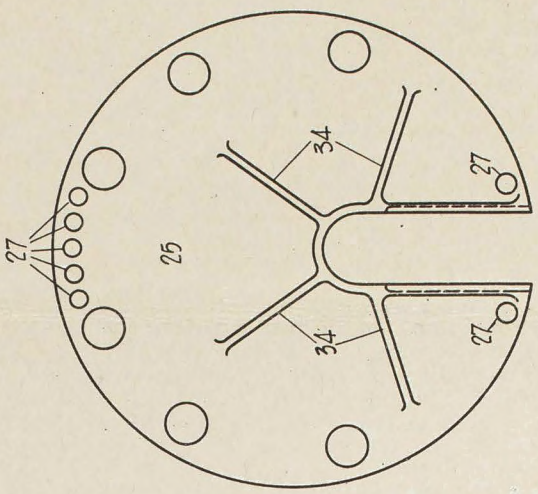


FIG. 3

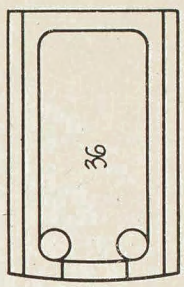


FIG. 4

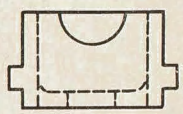


FIG 4A.

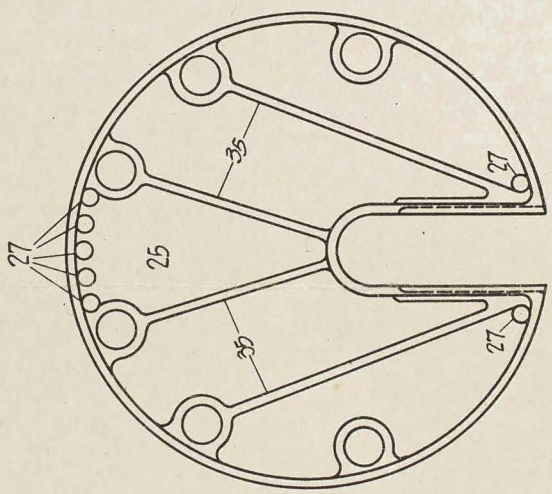


FIG. 2

Inventor : Gustav A. Kramer

By his Attorney B. Graham

Patented Nov. 26, 1935 2,022,205

UNITED STATES PATENT OFFICE

2,022,205

APPARATUS FOR THE TREATMENT OF IMMISCIBLE LIQUIDS

Gustav A. Kramer, New York, N. Y., assignor to Shell Development Company, San Francisco, Calif., a corporation of Delaware

Original application July 20, 1931, Serial No. 551,970. Divided and this application February 28, 1934, Serial No. 713,359. In Canada September 21, 1931

6 Claims. (Cl. 259—9)

This invention relates to a novel apparatus for contacting immiscible liquids with each other for the purpose of extraction, chemical treatment or the like, and more particularly to an apparatus wherein it is desired to carry out such contact in countercurrent relationship of the two liquids.

The preferred operation comprises passing two substantially immiscible liquids in countercurrent flow to each other through a plurality of stages arranged in contiguous relationship and communicating with each at a plurality of points, each alternate stage containing an agitating means, the end stages being characterized as quiescent or separating zones and each end stage containing an inlet and outlet for the liquids undergoing treatment. The emulsified liquids in the agitating zones are maintained in hydrostatic balance with the stratified liquids in the adjacent separating zones.

The foregoing and other objects and advantages of the invention, however, will be so clearly apparent to those skilled in the industry, as incidental to the following disclosure, that it would serve no useful purpose to further enlarge upon the same initially, and with these prefacing remarks, therefore, reference will now be immediately had to the accompanying drawings, generally illustrating at least one practical embodiment of a novel systematic combination of means for carrying forth the steps of the method involved, although not essentially the only apparatus for doing so, in which drawings

Fig. 1 is a sectional side elevation of the apparatus carried out according to this invention;

Fig. 2 is a front elevation of a diaphragm;

Fig. 3 is a rear elevation of a diaphragm;

Fig. 4 is a plan view of a diaphragm closing piece and Fig. 4*a* is an end view of the diaphragm closing piece.

In the drawings, wherein like characters of reference designate corresponding parts throughout the several views: 10 is a cylindrical shell provided with removable covers 11 and 12 and with an outer jacket 13 which may be utilized for heating or cooling the liquids in the mixer, should this be necessary. 20 is a shaft running parallel to the center line of shell 10 but preferably eccentrically located therein and supported in bearings 21. Stuffing glands 22 prevent leakage of liquids along the shaft when in motion, and specially formed end or ends of the shaft as shown at 23 permit connection to a prime mover by means of pulleys or couplings or the like. The shaft carries within the space enclosed by vessel 10, suitably spaced rotors 24 of any desired number which when revolving, agitate the liquid contained in the mixing device, causing intermingling of otherwise not miscible liquids in more or less fine emulsions. Diaphragms 25 are so spaced that one pair of them form a substantially enclosed space 26 in which the agitation of rotors 24 is not felt and is of such size that the emulsions formed in the mixing compartments may separate due to differences in specific gravity of the liquids in question.

Such diaphragms may be also placed between each end rotor and end plates 11 and 12 of the mixing vessel, or they may be omitted and external separating vessels substituted for this purpose.

The diaphragms 25 are closed on shaft 20 by means of diaphragm closing piece 36 which permits rotation of the shaft without substantial leakage of fluids between compartments.

The agitating and separating stages are in communication through openings 27 suitably placed near the upper and lower peripheries of the diaphragms and of such a size that they permit liquid to circulate between the two stages without causing the turbulence of the mixing zones to be communicated to the separating zones. Vanes 34 tend to increase the turbulence and eddy flow in the agitating compartments whereas vanes 35 tend to straighten out eddy flow in the separating compartments thereby expediting stratification of the immiscible fluids. Openings 28, 29, 30 and 31 are provided for feeding into and discharging from the vessel 10, the materials to be interacted, while openings 32 may be provided for sampling the liquids at various steps of the process. Coil 33 may be provided for additional internal cooling, either by water or by other refrigerating media or may be utilized for heating purposes, if so desired, by the passage therethrough of hot water, steam or other heating media.

The operation of the device may possibly be best understood by first considering the rotors at rest and supposing that two immiscible liquids of different specific gravities, e. g., sulfuric acid and hydrocarbon oil have been placed into the apparatus so that practically the entire space within the shell 10 is filled with liquid. The two liquids will naturally rest in the device in such a manner that the heavier one occupies a lower layer, the lighter one resting on top as, for example, shown by the dividing line drawn in Fig. 1.

If now the rotors are set in motion, the two liquids in the mixing compartments will be emulsified, but no substantial disturbance of the sep-

arated liquids occurs in the separating compartments because the total hydraulic head acting on openings 27 from the mixing compartment is still the same as that from the neighboring separating compartment. If we now remove some of the heavy liquid through opening 31, the deficiency will be made up by additional liquid flowing in through the openings of diaphragm 25. However, this incoming liquid contains not only sulfuric acid, but also admixed hydrocarbon, so that after separation of the two, the level of sulfuric acid in this compartment will be lower than that corresponding to the hydraulic head necessary to maintain equilibrium. Consequently, some additional liquid will flow into this separating comparment through the lower openings of the diaphragm 25 and some hydrocarbon through the upper openings of the diaphragm 25 back into the neighboring mixing compartment, until by separation of the incoming emulsion, sufficient acid has been accumulated to again establish equilibrium. Similarly, if the equilibrium were disturbed by feeding some additional acid into the opening 29, this acid will again disturb the hydraulic equilibrium and will force more acid through the lower openings of the neighboring diaphragm and so on through the entire device until equilibrium has again been reached.

By the same way, additional hydrocarbon fed into opening 30 would again be gradually distributed through the entire system, meanwhile being successively agitated with acid by the rotors in the mixing chambers.

If hydrocarbon is fed continuously into opening 30 and is being continuously removed at the same rate through opening 28, at the same time acid is being fed into nozzle 29 and being removed at the same rate through nozzle 31, it is easily understood that while the dividing levels in the separating compartments remain substantially unchanged, the acid and hydrocarbon come into thorough contact with each other in countercurrent, fresh acid always being contacted with nearly fully treated hydrocarbon and untreated hydrocarbon with nearly fully spent acid.

The relative time of contact may be varied independent of the throughput. Assume the volumetric capacity of the shell to be 200 gallons and that it contains 100 gallons of each liquid, the hourly feed also being 100 gallons of each. The average contact time of each of the liquids will then be one hour. If the contents of the shell are changed to 50 gallons of the light liquid and 150 gallons of the heavy liquid, the throughput being kept at 100 gallons per hour for each of the liquids, then the average contact time for the light liquid will be reduced to one-half hour and that for the heavy liquid increased to one and one-half hours; the ratio of the contact times of the two liquids thereby decreasing from 1 to ⅓. In similar manner, the relative time of contact of the light or heavy liquid may be either increased or decreased, depending on the character of the substantially immiscible liquids and the economic conditions of operation.

Under certain circumstances, it may be desirable to effect the contact of the two substantially immiscible fluids by means of parallel flow, in which case the lighter fluid is introduced at 30 and removed at the same rate through 28, while the heavier fluid is fed in at 31 and removed at the same rate through 29.

The number of agitating and settling chambers employed is dependent on the character of the liquids undergoing treatment and the nature of the process. For example, in parallel flow, an agitating chamber in communication with two settling chambers may suffice whereas in countercurrent flow a plurality of agitating chambers is desirable, the efficiency of the process increasing with the number of agitating compartments.

If the volumetric capacity of any of the end settling zones is insufficient to permit a well defined separation to take place, but instead an emulsified mass is present, stratification of said emulsified mass can be caused to take place by introducing said mass into one or more auxiliary surge tanks which, for all practical purposes, serve to compensate for the inadequate volumetric capacity of any end settling zone. The auxiliary tank or tanks may thus be regarded as comprising part of the end settling zone or zones.

By way of example, only, reference will be had to the treatment of a mineral oil fraction consisting essentially of hydrocarbons containing four carbon atoms to the molecule with sulfuric acid of such strength that the tertiary-base olefines contained therein, such as isobutylene, are selectively absorbed by the sulfuric acid and removed therewith, although it is to be understood that the process and apparatus is applicable to the treatment of any mineral oil fraction containing hydrocarbons of any number of carbon atoms to the molecule with an acid which may comprise H_2SO_4, H_3PO_4, HCl, etc. Pentane-pentene and hexane-hexene fractions are very suitable for treatment by my process for the selective absorption and removal of tertiary-base olefines (olefines capable of yielding tertiary alcohols upon hydrolysis).

A butane-butene fraction containing approximately 15 to 20% by weight of tertiary or gamma butylene is introduced at 30 while an equivalent amount of 65 to 70% H_2SO_4 is introduced at 29. To insure the complete absorption and removal of the gamma butylene, about a 10% excess of 65 to 70% H_2SO_4 is introduced at 29 (the amount of H_2SO_4 to be added being calculated on the amount of isobutylene to be absorbed). The vessel 10 in the meantime has been filled with 65 to 70% H_2SO_4 and the butane-butene fraction to be treated, the exact proportion of the contents of the vessel being dependent on the desired relative time of contact. The liquids flow in countercurrent fashion, the efflux at 28 comprising the butane-butene fraction from which the isobutylene has been substantially removed while the efflux at 31 comprises H_2SO_4 relatively saturated with isobutylene. The temperature is maintained between about 80° to 90° F. to avoid substantial polymerization of the butene-1 and butene-2. The pressure in the vessel is approximately the vapor pressure of the butane-butene fraction at the operating temperature.

The apparatus assures ease of control, simplicity and flexibility of operation and maximum yield in the optimum minimum time of contact.

This application is a division of my application Serial No. 551,970, filed July 20, 1931, which issued April 3, 1934, as U. S. Patent 1,953,618.

It will be obvious that various substitutions in the materials treated and in the liquids used, as well as modifications in the order and manner of execution may be made in the practical application of the invention, but such substitutions and modifications are to be considered as comprehended by the above disclosure and included within the purview of the following claims.

I claim as my invention:

1. An apparatus for the treatment of substan-

tially immiscible fluids which comprises a plurality of treating zones arranged in substantially horizontal contiguous relationship and communicating with each other at a plurality of points, each alternate zone containing agitating means, each intermediate zone comprising a settling zone and the end zones comprising separating compartments, each end zone containing an inlet and an outlet for the liquids undergoing treatment, said communicating zones being open for the free passage of fluid at a plurality of points, whose loci are at substantially opposite ends of a vertical axis drawn in the plane of a side of a zone.

2. An apparatus for the treatment of substantially immiscible fluids which comprises a vessel, a plurality of diaphragms dividing said vessel into a plurality of treating zones arranged in contiguous relationship, each of the diaphragms being perforated at the upper and lower portions of its periphery with openings of such a size that they permit liquid to circulate between two communicating treating zones without causing the turbulence of a mixing zone to be communicated to a separating zone, said lower set of perforations being so arranged that removal of fluid from an end treating zone will cause automatic flow of fluid from all the other treating zones to said end zone, and agitating means disposed in alternate treating zones, each end zone containing an inlet and outlet for the liquids undergoing treatment.

3. An apparatus for the treatment of substantially immiscible fluids which comprises a vessel, a plurality of diaphragms dividing said vessel into a plurality of treating zones arranged in contiguous relationship, each of the diaphragms being perforated at the upper and lower portions of its periphery with openings of such a size that they permit liquid to circulate between two communicating treating zones without causing the turbulence of a mixing zone to be communicated to a separating zone, said lower set of perforations being so arranged that removal of fluid from an end treating zone will cause automatic flow of fluid from all the other treating zones to said end zone, guide vanes located on the walls of the diaphragms, and agitating means disposed in alternate treating zones, each end zone containing an inlet and outlet for the liquids undergoing treatment.

4. An apparatus for the treatment of substantially immiscible fluids which comprises a vessel, a plurality of diaphragms dividing said vessel into a plurality of treating compartments arranged in contiguous relationship, each of the diaphragms being perforated at the upper and lower portions of its periphery with openings of such a size that they permit liquid to circulate between two communicating treating zones without causing the turbulence of a mixing zone to be communicated to a separating zone, said lower set of perforations being so arranged that removal of fluid from an end treating zone will cause automatic flow of fluid from all the other treating zones to said end zone, guide vanes located on the walls of the diaphragms, a shaft disposed within said vessel and eccentric with respect to the horizontal axis of said vessel, and agitating means supported on said shaft and located within alternate compartments, each end compartment containing an inlet and outlet for the liquids undergoing treatment.

5. An apparatus for the treatment of substantially immiscible fluids which comprises a series of substantially horizontally arranged agitating and settling compartments only the contiguous compartments of which are in communication with each other, agitating devices only located in alternate compartments and inlet and outlet means contained in each end compartment, said communicating compartments being open for the free passage of fluid at a plurality of points whose loci are at substantially opposite ends of a vertical axis drawn in a plane of a side of a compartment.

6. An apparatus for the treatment of substantially immiscible fluids which comprises a series of agitating and settling zones, each agitating zone being in communication with no more than two settling zones via openings of such size that they permit liquid to circulate between two zones without causing the turbulence of an agitating zone to be communicated to a settling zone, said openings being so arranged that removal of fluid from an end treating zone will cause automatic flow of fluid from all the other treating zones to said end zone, agitating devices located in alternate zones and inlet and outlet means contained in each end zone.

GUSTAV A. KRAMER.

AIRMAIL

March 22, 1949
No. 2362

Mr. George Meier
LONDON OFFICE

Dear George

Perhaps you will not love me for suggesting to Professor Szilard that he approach you on the matter of certain British patents of his which are referred to in the letter from him to you enclosed in this envelope. However, there is a genuine flattery involved which may partly compensate you for the trouble; for I told him that you were the only person I knew in England who was qualified by tact and temperament to handle the matter for him.

The letter from Szilard speaks for itself. The only further elucidation is necessitated by the fact that there may be some expenditures involved, e.g. prolongation proceedings should be started immediately on behalf of British patent 440,023. Such expenses may be met in any way that suits your judgment or convenience; you have my permission to use some of my personal funds there for the purpose, or your own funds, or funds of Trubenised Ltd. or Trubenised (G.B.) Ltd. so long as they appear as an expense at least for the old company.

Then there is also a matter of possible compensation, which involves the question: Who shall be compensated? You are entirely at liberty to handle this matter as a purely personal affair and to obtain compensation (if any) directly from Szilard on a contingent basis. It is difficult to discuss the matter in a vacuum, so to speak. Perhaps after you have explored the situation a little bit you will have some idea of the amount of work, money and profit involved.

One further point. Szilard is writing to Sir John Cockroft; the original of this letter to Cockroft is enclosed with Szilard's letter and is intended for mailing to Cockroft in England after copies of the patent have been obtained and attached to it. As director of the Atomic Energy Research Establishment, Sir John will undoubtedly give you all the necessary "steers" you may need. However, the main reason for Szilard's writing to Cockroft was that he wanted Cockroft to know in advance that this inquiry will be made to the British Government.

Yours sincerely

Ben Liebowitz

C

Liebowitz

Cable Address
TRUBENIZE NEW YORK

Telephone
MUrray Hill 5-6918

TRUBENIZING PROCESS CORPORATION
171 MADISON AVENUE
NEW YORK, N. Y., 10016

January 21, 1964

Dr. Leo Szilard
Du Pont Plaza Hotel
Du Pont Circle
Washington, D. C.

Dear Leo:

I am looking for somebody who is qualified to advise my grandson, Michael Wood, about his education as a physicist. He is completing his fourth undergraduate year at Rochester and finds that the pace is pretty fast - not enough time to learn to understand what one imbibes by rote.

The subject matter given to undergraduates now constitutes material which in the classical field I had studied as a graduate student. I well recall the difficulty in grasping the meaning of the various mathematical objects I was learning about. Physics has developed so far beyond what it was in my student days that the learning pressures become enormous; at the same time there has been no lengthening of the student period. The result is in some ways appalling. For example, my paper on the Aharonov-Bohm effect was rejected on grounds which Aharonov himself calls "stupid"; and Lloyd Motz (Professor of Astro Physics at Columbia) remarked "that referee does not know what he is talking about". It was a plain case of lack of understanding of classical electromagnetic theory at a fairly elementary level.

More to the point are comments made by Philip Abelson in an article in the current issue of "Science", on "Trends in Modern Science". If you get a chance, read the last paragraph of his discussion of Physics.

I have presented these preliminaries so that you will understand the background which led me to suggest to Michael that he take an extra year of undergraduate work at some other institution, a place like Princeton, or Harvard, or maybe Cambridge, England. His advisor at Rochester opposes this suggestion. The purpose of this note is to bespeak your advice as to some person or persons to whom Michael could go for advice of a more mature kind than he is getting.

One reason for mentioning Philip Abelson is that I would consider him as one of the best persons for Michael to talk to.

Do you know him, if so could you give Michael a letter of introduction to him? Or is there anyone else whom you might suggest?

In this connection, it should be borne in mind that I am committed to seeing Michael through his undergraduate work, at least. Hence in this instance, financial pressures do not enter.

I am looking forward to hearing from you soon.

As ever,

BL:s

P. S. Enclosed is copy of my last letter to Michael. Copy of this letter to you is going to Michael.

cc: Michael D. Wood
P. O. Box 5215
River Campus Station
Rochester, N.Y. 14627

January 21, 1964

Dear Michael:

In accordance with your letter of January 16th, I am sending you herewith a check for $500. Also enclosed is a promissory note for $1500. I have previously explained to you why the monies which I am advancing to you at the present time are to be regarded as loans which will be wiped out later, when I can make the necessary gifts without paying gift tax.

I had intended to bring with me from the country this morning an article by Philip Abelson published in the current issue of "Science". Besides being editor of "Science", he is head of the Department of Geo. Physics at the Carnegie Institute in Washington. I have no doubt that Abelson is a very able scientist but my high regard for him is based on the evidence he shows of being a real human being. The article in "Science" is entitled, "Trends in Modern Science". In discussing physics, he points out that there is a woeful lack of adequate training in classical physics, both mechanics and electrodynamics. He closes his discussion on the science of physics by citing an example of a young man who, it seems, would not be able to prove that a ball will fall!

So you see I am not alone in holding that great pressures in physical sciences are leaving its most fundamental branch, namely, classical physics, to be skimmed over.

In studying any science, or art, whether it be ornithology, medicine, or physics, hard work cannot be avoided - and that means a great deal of <u>rote learning</u>. To an extent I agree with your advisor. However, your advisor may well be unaware of the intense conflict between rote learning and broad imaginative or creative thinking. So I will try to help you find some other advisor who will take a broader view of the situation. In the meanwhile, do not neglect the routine matters of applying to various universities on the assumption, at the present moment, that you will <u>not</u> take an extra year of undergraduate work. I hoper you realize the importance of this.

I have been cudgeling my brain to try to find someone who would really be qualified to advise a young

man like you. I am enclosing a copy of letter to Leo Szilard.

Love

Enclosure

P. S. Have you discussed this matter with Ramsay and Naomi? I think you should.

Mr. Michael D. Wood
P. O. Box 5215
River Campus Station
Rochester, N. Y.

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

Leo Szilard

24 January, 1964

Dr. Benjamin Liedowitz
Trubenizing Process Corporation
171 Madison Avenue
New York, N.Y.

Dear Ben:

I have your letter of January 21, regarding Michael Wood. I shall be glad to see him myself in order to determine what is his real problem. Thereafter, I will suggest someone he might see for the advice he seems to need.

I could see him in Washington between February 7 and 19. He ought to check with the Hotel Dupont Plaza whether I am in Washington, and make a date with me before he comes.

Right now I am at La Jolla and I shall be back in La Jolla by February 22 when I expect to stay two weeks. My plans for March are uncertain and from April 1 on I expect to spend most of my time in La Jolla.

With kind regards,

Sincerely,

Leo Szilard

LS:jm

file
Leo Szilard

BENJAMIN LIEBOWITZ
NEW YORK, N.Y.
171 Madison Avenue

February 19, 1964

Dear Leo:

Virginia and I have just returned from a short week's trip to Florida - the purpose of the fleeing being to escape any celebration of our 50th wedding anniversary!

Michael would much appreciate an opportunity to have a talk with you but the possibility of such a meeting must depend upon your plans. Michael will be at home during the Easter recess, that is from March 22nd to March 30th. Is there any possibility that you will be in Washington during that period?

As ever,

BL:s

cc: Mr. Michael Wood

answered

Dr. Leo Szilard
Du Pont Plaza Hotel
Du Pont Circle
Washington, D. C.