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Research Supplement to
Scientific Intelligence Report
CIA/SI 2-57

CONTRIBUTIONS OF GERMAN SCIENTISTS TO THE ATOMIC ENERGY PROGRAM SINOP

CIA/SI 2-RS I-57

15 April 1957

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PREFACE

This is one of a series of six reports dealing with the activities of the German scientists who were imported into the Soviet Union in 1945 to do work related to the development and expansion of the Soviet Atomic Energy Program.

A summary report, CIA/SI 2-57, Contributions of German Scientists to the Soviet Atomic Energy Program, January 1957, Secret, deals with the over-all aspects of the German contributions. See also:

CIA/SI 2-RS II-57	Contributions of German Scientists to the Soviet Atomic Energy Program - SUNGUL Secret
CIA/SI 2-RS III-57	Contributions of German Scientists to the Soviet Atomic Energy Program - AGUDZERI Secret
CIA/SI 2-RS-IV-57	Contributions of German Scientists to the Soviet Atomic Energy Program - ELEKTROSTAL Secret
CIA/SI 2-RS V-57	Contributions of German Scientists to the Soviet Atomic Energy Program - OBNINSKOYE Secret

All information presented herein has been obtained from the testimonies of returned German and Austrian scientists and technicians.

Intelligence research ended 15 August 1956.

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CONTRIBUTIONS OF GERMAN SCIENTISTS TO THE SOVIET ATOMIC ENERGY PROGRAM SINOP INSTITUTE

PROBLEM

To determine the role played by the German scientists at Sinop in contributing to the development of the Soviet atomic energy program.

CONCLUSIONS

1. German scientists-Thiessen and his "group" at the Sinop Institute from 1945 to 1952 developed a wire-mesh backed diffusion barrier which was of great importance to the Soviet atomic energy program, being second only to the German uranium production work at Elektrostal.

2. The electromagnetic isotope separation research carried out by the von Ardenne group also contributed to the success of the Soviet atomic energy program. Their efforts relieved the Soviet scientists from devoting considerable time to this particularly important phase of the research program.

3. Steenbeck's research and development on the ultracentrifuge contributed to the overall atomic research program in that his group investigated and reported on one feasible method of isotope separation.

4. The ion source research and development by the von Ardenne group is believed to be the forerunner to the work on the Soviet accelerator program.

DISCUSSION

Introduction

The research institute at Sinop is one of the two main research institutes which the Soviets set up in the Sukhumi area to accommodate the German and Austrian scientists brought into the Soviet Union during 1945 to work on their atomic energy program. The Institute was located some 2 to 2½ miles south of Sukhumi and approximately 3½ miles northeast of Agudzeri, the location of the second institute in this area. The Institute buildings, formerly an Intourist Hotel, were located on an elevation some 650 yards from the shore of the Black Sea. This institute has been referred to as the "Institute von Ardenne", "Obyekt Sinop", and Obyekt 'A'". In this report the institute is referred to as the Sinop institute.

The first contingent of German and Austrian contract scientists arrived at the institute in the fall of 1945. Manfred von Ardenne had previously been designated as the German "scientific chief" of the institute. This small group of contract scientists could serve only as the nucleus of the staff for such an institute. Additional technical and semi-technical personnel were necessary to

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serve as laboratory assistants and technicians. The Soviets carefully screened the inmates of all prisoner-of-war camps throughout Soviet occupied or controlled territories. All prisoners with a suitable background were further interviewed by some member of the German Sinop staff. Their qualifications were apparently presented to the German chiefs of the institute and in this manner the prisoners were chosen and sent to the particular installation where they were to work. The technicians thus selected for work at Sinop began to arrive at the institute in 1946 and in late 1946 the Institute became operative. Eventually these POW's were offered the opportunity to sign contracts to continue working in the Soviet Union at higher salaries. Many signed, but others felt that signing such a contract would result in their being retained in the Soviet Union for a longer period. These prisoner technicians were retained at the Sinop installation until late 1949 before being released to camps for eventual repatriation.

The primary research assignment of Sinop was that of isotope separation. The individual phases of the overall problem were divided between this institute and that at Agudzeri. Three specific problems were assigned for study at Sinop. The entire program of the Institute was under the general supervision of Von Ardenne, who was also personally responsible for the research being conducted on the problem of electromagnetic separation of isotopes. Thiessen led the research directed toward the development and production of a diffusion barrier. Steenbeck led all work being done on separation of isotopes by use of an ultracentrifuge. Each of these items will be discussed below. Other tasks were: (1) the design and construction of a desk type electron microscope of which only the electric components were completed in September 1949. This work was done under the direction of Reibedanz; (2) the design of a cyclotron, also under the direction of Reibedanz, which was discontinued in 1947, and (3) the study of the physiological and biological effects of radiations upon plants and animals, under the direction of Menke. This last task was discontinued at Sinop when the Menke group was transferred to Sungul in 1948.

DEPARTMENT I: The von Ardenne Group

By the end of 1945, Baron Manfred von Ardenne had won the confidence of the Soviets who held him in high esteem as a scientist. His colleagues, however, considered him to be a charlaton and by no means an able scientist. His main forte recognized by all, was his ability to organize a group of researchers and exploit their work to his own advantage.

When the institute at Sinop was activated, von Ardenne was installed as the chief German scientific director of the entire institute and held the specific position of Chief of Department I. To this particular department was assigned the task of investigating the problem of electromagnetic separation of the isotopes in general and of the isotopes of uranium in particular.

When Department I was first established it consisted of Manfred von Ardenne,

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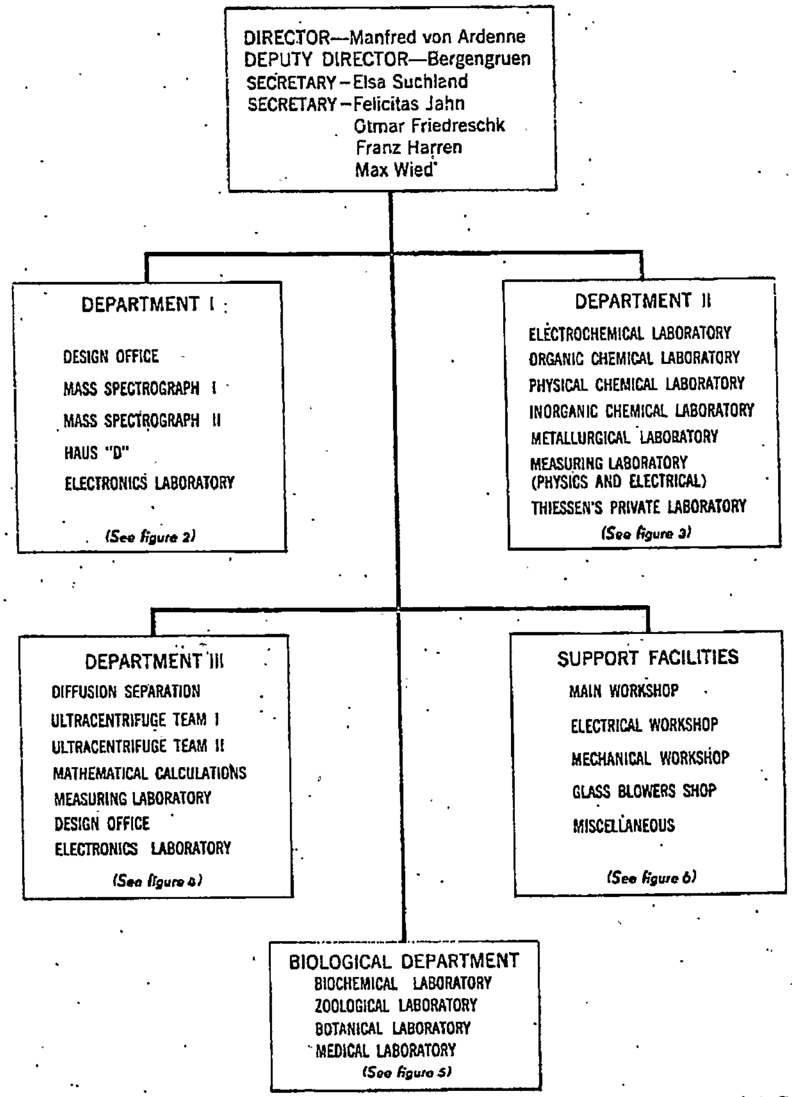
Figure 1

ORGANIZATION OF THE SINOP INSTITUTE ADMINISTRATION



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Reibedanz, Jaeger, and Roggenbuck. This group was not sufficiently large to carry out the assigned investigation. At the suggestion of von Ardenne, Emil Lorenz was forcibly brought from Berlin to the Soviet Union and to the institute at Sinop. He was assigned to von Ardenne who considered him as his "universal engineer" and a great potential help to the group. Through the prisoner-of-war recruitment program, the Ardenne group was further augmented by Dr. Steudel, Dr. Lehmann, Dr. Mueller, Dr. Froehlich, Uerlings, and Schmal as well as a large number of laboratory technicians and assistants. To this group were also assigned a number of Soviet scientists among whom were Demikhanov, Chkuaseli, Gusev and his wife. The Soviets were no more than technicians but were assigned as "Soviet Scientists."

Dr. Steudel worked with Department I for only a short period of time and, after a violent argument with von Ardenne, was transferred to the ultracentrifuge group under the leadership of Max Steenbeck. Dr. Lehmann assumed responsibility for the Ceramic Laboratory and was assigned the task of developing a suitable crucible for use in a high intensity ion source such as would be needed for the electromagnetic separation project. Emil Lorenz was made responsible for system design and construction. Froehlich, Uerling and Mueller were responsible for the development of the high-voltage equipment necessary for the research and development of the ion source and electromagnetic separation apparatus.

In the fall of 1947 the overall responsibility for the research project was transferred from the institute at Sinop to Elektrosila, at Leningrad. This transfer was initiated chiefly as a result of having only a 60 ton magnet available at Sinop while there was a 200 ton magnet available at the Elektrosila plant at Leningrad. The electromagnetic separation research work at Sinop now became merely a support project for the main research being conducted at Elektrosila. When the project was transferred to Elektrosila, German personnel were also transferred so that the project remained one of German responsibility despite the change in location. The Soviet personnel at Elektrosila acted only in the capacity of consultants.

In 1949, Professor Vekshinskiy, a Soviet high vacuum specialists, initiated a competitive program at Elektrosila. He is reported to have been using UO_2 as his source material. There was a free transfer of research data and information from the German research workers to Laboratory II, but the Germans were allowed no access whatsoever to the results of the research being performed at Laboratory II nor to that of the work being conducted by the group under Vekshinskiy at Elektrosila. In fact, the German scientists were denied the use of the library facilities which were available at Leningrad, thus necessitating their performing much unnecessary work.

The research work of the German scientists at Elektrosila was completed in July 1950 and the group was returned to the institute at Sinop. Their work there from 1950 until they were repatriated in 1955 was of only minor importance insofar as the overall Soviet program was concerned. They did considerable work on "[illegible] guns" of two types: 1) One suitable for pulse operation, and 2) one suitable for continuous operation. This work could have been used in some phase of the Soviet high energy accelerator program.

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When the Germans at Sinop first started the research on the development of an ion source for use in an electromagnetic separation system, they used UF_4 as an initial source material. This salt was heated in an "oven" to a temperature of from 500° to 600°C. The vapors thus produced were then passed into the ionization chamber. The cathode of the chamber was a tungsten ribbon with a smooth emitting surface. This source produced ion currents of from 10 milliamperes to 15 milliamperes but there was very poor line definition. Also there was a decimeter oscillation set up in the equipment and this proved to be a very troublesome source of interference.

In order to overcome some of the difficulties which they had encountered and to increase the ion current without a corresponding increase in the spectral spread, the research was carried into the field of higher temperatures and a metallic uranium source was brought into service. The use of metallic uranium as a source required the use of crucibles that were able to withstand very high temperatures. Fortunately, Dr. Lehmann, of the Ceramic Laboratory, had been successful in producing high temperature crucibles made from thorium oxide and from beryllium oxide. By making use of these newly developed crucibles they were able to operate at temperatures of from 1600° to 1800°C. At this temperature the crucible was sufficiently conductive to act as the anode. One problem encountered in this work was that of the gradual disintegration of the crucible walls caused largely by erosion and electrolytic action. The molten metal rotated by the action of the magnetic field would erode the crucible. An electrolytic exchange would further tend to contaminate the uranium melt with thorium or beryllium from the crucible wall. This caused also a formation of uranium oxide which would still further contaminate the material of the source. It is reported that this was partially overcome by the insertion of a tungsten wire through a hole bored in the bottom of the crucible. This wire, which was fused to the crucible, would then act as the anode, thus providing essentially a point anode rather than one with the large area which was provided by the surface of the molten metal.

In early 1947 the provisional high voltage and feeder installations for the 60 ton magnet at Sinop were replaced in an effort to stabilize the system. The new installation provided a maximum of 60 kilovolts at 30 to 40 milliamperes. Even with the improved system they were only able to get ion currents of 6 milliamperes to 8 milliamperes, a uranium evaporation rate of 1 to 1.5 mass grams per hour and a line dispersion of only four millimeters due to the small magent which was being used. It was thought that it would be impossible, using the equipment they had, to obtain ion currents higher than 6 to 8 milliamperes and still retain a relatively well defined line system. Doubling of the arc length gave only an ion current of 10 milliamperes with a corresponding decrease in line definition. The current could be increased to 20 milliamperes but under the conditions the definition was so poor and the line so inhomogenous that it was no longer of any use in separation experiments. This performance served to indicate the necessity for having a larger magnet. Since it was impractical, at this time to install a larger magnet at Sinop, the entire basic project was transferred to Elektrosila at Leningrad in late 1947. This was done to make it possible to utilize the 200 ton magnet that was there, for further work on this project. Some of the German

...ists and technicians that had been working on the project at Sinop were ...ed with the equipment and continued their work at Elektrosila.

...e first six months after the transfer of the project to Elektrosila were ...t in setting up the equipment, perfecting the vacuum, and working out "bugs" in the entire system. The magnet was a 200 ton magnet with a fixed pole separation. Its power supply was a power-pack capable of supplying a maximum current of 1200 amperes at 50 volts. The chamber which was placed between the pole faces was made up of four brass sides and an iron top and bottom. The chamber was 1200 x 3000 x 400 millimeters and was provided with all the proper openings for the insertion of components and for making the proper connections. The pumping unit consisted of two identical systems using Soviet produced oil-diffusion pumps. The pumps had an inner diameter of some 400 millimeters, filament energy requirement of some 15 kilovolt amperes and, a capacity of 1500 liters per second for each pump at a pressure of 10^{-4} Torr. Each system used an American Kinney rotary pump as a backing pump. Another rotary pump was used for pre-evacuation of the entire system.

After the installation was completed and the complete system checked out, by late spring 1948, the problem then became one of a desperate attempt to obtain increased positive currents and yet retain suitable line definition. After trying various schemes an ion current of ten milliamperes with acceptable line definition was achieved. This compared favorably with the 15 milliamperes obtained by Laboratory II in a device that was limited strictly to laboratory use. However, in 1949, Laboratory II enclosed the entire length of the plasma column and were able to produce ion currents of about 50 milliamperes and still maintain acceptable line definition. It has been reported that Laboratory II obtained an ion current of some 200 milliamperes by the summer of 1950. Some of the more significant operational data as recalled by the chief source are:

a. Heater: 1200 amperes, 11 volts, 2400°C.
b. Cathode: 150 amperes, 2 volts.
c. Temperature of the focal spot of the melt: 1800°C.
d. Main arc: 0.5 to 0.6 amperes, 400 to 500 volts.
e. Auxiliary arc: 0.4 to 0.6 amperes, 400 to 1000 volts.
f. Positive current: 50 to 60 milliamperes, positive potential: 35 KV.
g. Evaporation rate: 1.2 grams per hour.
h. Source life: 35 to 40 hours.
i. Acceleration distance: 12 to 14 millimeters.
j. Average path radius: 90 centimeters
k. Aperture angle of fan: 16°
l. Magnetic field: 500 gauss
m. Vacuum: 2 to 5×10^{-5} Torr
n. Pumping capacity: 300 to 500 liters per second at 5×10^{-5} Torr
o. Separation factor: 40

When the Germans did the research they were obtaining a separation factor of only 20. This was later determined to be a result of the improper alignment or shimming of the magnet. Vekshinskiy knew that the magnet was improperly shimmed

Figure 2

but did not do inform the Germans since an all-out attempt was being made by most of the Soviet scientists to completely discredit the German scientists and their work. Vekshinskiy himself took one of the German produced ion sources and tested it with his own magnet which was properly shimmed and obtained a separation factor of 40 without any difficulty. When the German scientists were being berated by the Soviets of the Ninth Directorate for having failed in their project, Artsimovich revealed the subterfuge and protested against the unfair treatment of the Germans who were working on the problem. The apparatus is reported to have had an efficiency of some 20 to 23 percent. The remaining uranium could be recovered by periodic cleaning of the apparatus.

On 1 August 1950, the German scientists, working on the project at Elektrosila, completed their work and were returned to Sinop shortly thereafter. In 1952, a 200 ton magnet, together with the necessary power-packs and high voltage installations, was moved to the institute at Sinop. The installation was set up and research was started on improving the method of separating, electromagnetically, isotopes of other economically important metals. The ion source used in this work was of the same type as that developed in the work at Elektrosila. For the more easily evaporated metals, positive currents up to some 250 milliamperes could be used and acceptable line definition maintained.

The final disposition of the project for the development of electromagnetic separation of uranium isotopes is unknown. The Germans felt that the Soviets built no production plant making use of electromagnetic separation process for obtaining U-235, having adopted the gaseous diffusion process for this part of their program. It is possible, however, that they are making use of this process for production scale separation of isotopes of other metals. Still another possibility is that the process is used in conjunction with the gaseous diffusion separation process in some manner.

Since there is no evidence to indicate that the Soviets made direct application of the electromagnetic separation process to their nuclear energy program it is questionable whether the work of the Sinop group of Germans made any great direct contribution to the success of the program. The fact that the group was awarded several bonuses and cash awards indicates that they did contribute to the program in some worthwhile manner.

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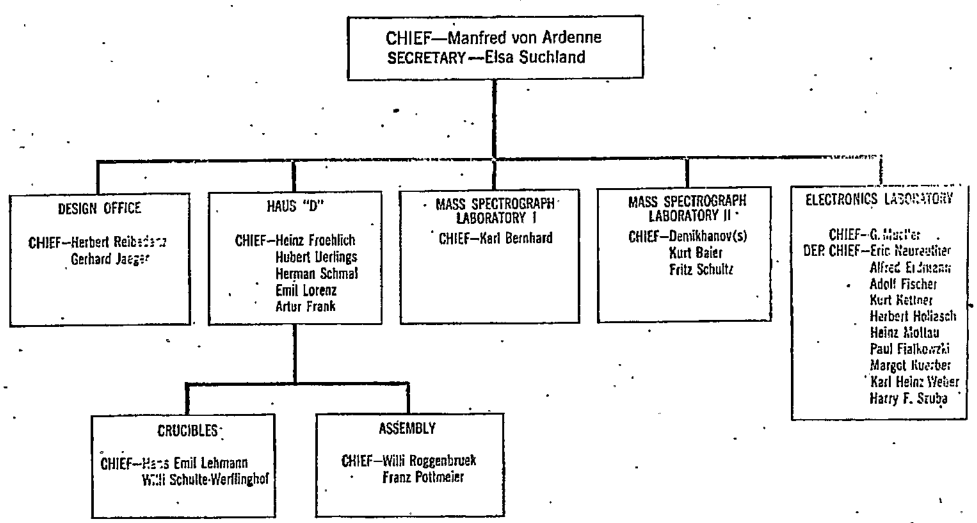
SINOP INSTITUTE



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[illegible] II - Thiessen Group

Professor Adolph Thiessen headed a group of German scientists at the Sinop Institute which contributed heavily to the success of the Soviet gaseous diffusion uranium isotope separation program. Starting early in 1947, this group developed a nickel mesh-backed tubular barrier which was put into pilot plant production in 1948 and was in full scale production by the end of 1949. This Thiessen barrier was very probably used in one or more of the major Soviet gaseous diffusion plants built after 1949.

The first Soviet barrier for gaseous diffusion of separation of uranium isotopes was designed and built by the Soviets themselves without known German help. This was a flat plate barrier, probably made by etching a nickel alloy. This barrier was used in the first Soviet gaseous diffusion plant at Verkhneivinsk, sections of which were in operation in 1948.

Early in 1947 the Soviets instructed the German groups at Sinop and Agudzeri to develop tubular nickel barriers. This instruction may have stemmed from early Soviet recognition of the sealing and gas mixing problems likely to be encountered with flat plate barrier, or may simply have indicated a Soviet desire to explore an alternate approach to the problem.

The barrier development at Agudzeri was assigned to Reinhold Reichmann who developed an extruded nickel tubular barrier prior to his death in 1948. After Reichmann's death the further development of his barrier fell behind that of the Thiessen barrier, and the use of the Reichmann barrier in plants was probably not begun for more than two years after the Thiessen barrier was in full production.

German sources differ in their opinions of the relative merits of Thiessen and Reichmann barriers. The two appear to be quite similar in their separative characteristics. The Thiessen barrier was certainly superior in mechanical strength and the Reichmann barrier was probably cheaper to produce.

Pilot plants for both types of barrier were started at Elektrostal, near Moscow, in 1948, but the first successful Reichmann barrier pilot plant was probably not in operation until 1951. Whether Reichmann barrier ever went into full production is not positively known, but awards in 1952 to Reichmann's widow and to Reichmann's Soviet successor, Yermin, suggest that the Soviets gained substantial benefits from the development.

The full story of Reichmann barrier is told elsewhere in this paper and will not be repeated here. It is of interest to note, however, that Thiessen was called into the Reichmann barrier program after development of his own barrier was complete in 1951, and that Thiessen may well have contributed materially to the Reichmann barrier program.

The Thiessen barrier was relatively simple to produce although the expense of the ingredients, complicated by uneconomical manufacturing methods, made the

Thiessen barrier very expensive. The backing of the barrier was a very fine nickel wire mesh which was initially purchased in East Germany. The Soviets also purchased German machinery for making this mesh and presumably set up mesh manufacturing facilities in the Soviet Union. Very large quantities of mesh were procured in East Germany from 1948 through 1952, when mesh procurement came to an abrupt end. The end of mesh procurement probably marked the end of Thiessen barrier production. The Reichmann barrier may have been substituted for Thiessen barrier in 1953, or some other barrier unknown to the German sources may have been adopted.

Mesh procurement may have been resumed in early 1956, although the evidence of this is not quite conclusive to date. If this production has been resumed it may signal a return to Thiessen barrier or, more probably, to some similar but improved barrier which requires mesh backing for strength or for other characteristics.

The nickel wire mesh was shipped from East Germany through transfer points to the First Chief Directorate factory at Elektrostal, where it was made into barrier. Martin Krecker, one of Thiessen's assistants, has described the process used to cut this mesh into rectangles at Elektrostal in 1949. Waldemar von Maydell, another member of the Thiessen group, has described a different but almost equally inefficient cutting method used at Sinop and presumably later adopted at Elektrostal. It was apparently necessary to cut the mesh at a 45 degree angle with the weave resulting in the wastage of almost one half of all the mesh procured. Krecker says that the bias cutting was necessary to prevent warping during a subsequent rolling operation; and other sources have said it was required for rigidity of the completed tubes. Efforts were made to decrease this loss through development of machine cutting methods, but the only known development in this direction resulted in failure. A May 1952 change in mesh specifications permitted more irregularities in the mesh if these irregularities were confined to the outer edge of the mesh bolts. This change suggests that straight-across cutting may have been started then. If this suggestion is valid, then it must be concluded that the experiment was a failure, since the mesh specifications reverted to their old standards in July 1952.

The mesh was cut on tables, using metal templates and shears. The rectangular pieces, slightly larger in area than the finished barrier, were then placed in frames and sprayed with fine nickel powder. The nickel powder was obtained from the high temperature decomposition of nickel carbonyl gas, another development of the Thiessen group. The framed rectangles were sintered in ovens and then removed from the frames and trimmed to size. After a rolling process the rectangles were bent into tubes and welded. Nickel fittings were next welded on one end of these tubes and sylphon bellows were applied to the other end. The tubes were then packed and shipped to unknown destinations, presumably the Soviet gaseous diffusion plants in the Urals region.

The early Thiessen barrier suffered from susceptibility to uranium hexafluoride corrosion, un-uniformity of pore sizes, and lack of mechanical strength.

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Figure [illegible]

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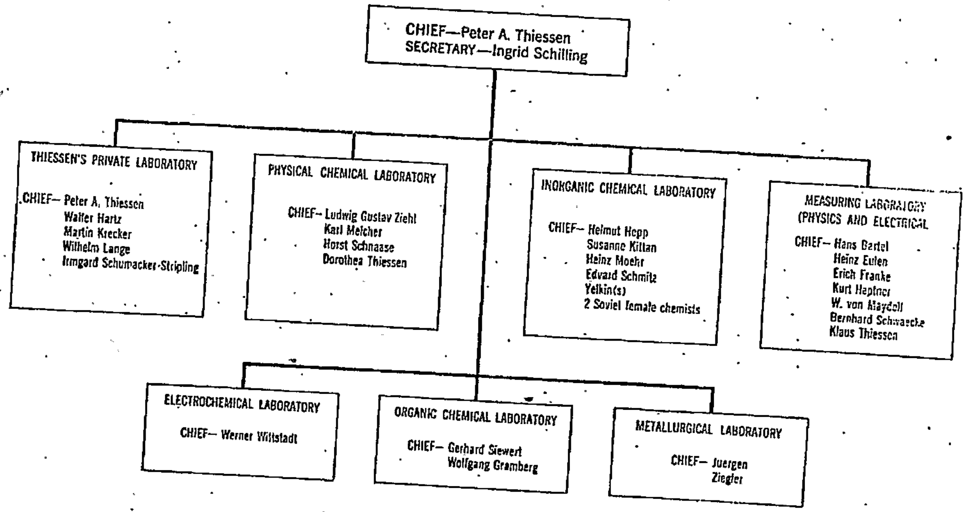

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During the latter part of 1948 and the first quarter of 1949 an annealing process was developed at Sinop which presumably was incorporated into the post-1949 Elektrostal production. This process, together with the passivization techniques worked out by Ikert, Zuehlke (at Agudzeri) and others so reduced corrosion that the corrosion rate became immeasurably small by mid-1949. The annealed barrier was also much stronger than the old barrier had been. It is not known whether the problem of non-uniform pore sizes in the barrier was ever solved.

In the spring of 1949 two and three layer versions of the Thiessen barrier were developed at Sinop. These consisted of barriers made by successive applications of nickel powder of decreasing particle sizes. The different particle sizes were separated for use in this process by repetitive sedimentation in a series of settling tanks. Factory instructions were prepared for this process, but it is not known if this method was ever placed in production.

The Thiessen group took part in later developments of aluminum barrier and of a sedimented nickel powder barrier made without the use of nickel mesh backing. These developments came close to the end of the time the Thiessen group worked on classified projects and the details of the developments and their subsequent acceptance or rejection by the Soviets are unknown.

Thiessen himself contributed individually to the success of the Soviet gaseous diffusion program in addition to the contributions with which his group was associated. He visited Elektrostal several times in connection, presumably with barrier production problems, and paid at least one vist to the Soviet gaseous diffusion plant at Verkhneivinsk to advise in connection with the serious early production problems which arose there. The success of this Thiessen visit was attested by Heinz Barwich.

After the rest of the original Thiessen group were taken off classified work, Thiessen himself continued to work in the Soviet atomic energy program for some time. The specific nature of this continuing work is unknown at present, but he told several sources that he would be a consultant on barrier problems. His continuing association with classified work has delayed Thiessen's return from the USSR.

The contributions of Thiessen and of his group of German scientists at Sinop must be ranked high among the German contributions to the Soviet atomic energy program. Thiessen gave the Soviets their first successful tubular barrier and this barrier was used in at least one gaseous diffusion plant. He also contributed to the development of Reichmann barrier and to the solutions of barrier production and uranium-235 production problems. The importance of his contributions ranks with or ahead of the gaseous diffusion theory contributions of Heinz Barwich, the mass spectograph developed by Werner Scheutze, and even the uranium metal production developed by Nickolaus Riehl and Guenther Wirths.

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DEPARTMENT III - Steenbeck Group

When Dr. Max Steenbeck arrived at Sinop in December 1945 he refused to subordinate himself to von Ardenne as the chief of all research work at the institute. Since this conflict was somewhat the same as had prevailed when Thiessen came to the institute, it was handled in the same manner as was Thiessen's case. Steenbeck was set up with a separate group and worked more or less independently of von Ardenne. This was the third group to be set up and was thus referred to as the third department or Department III.

When this so-called "Steenbeck Group" or "Department III" was organized, Steenbeck was assigned as his main project the problem of development and construction of an ultracentrifuge that would be capable of separating the isotopes of uranium.

Upon initial investigation the ultracentrifuge appeared to the Germans to be an ideal system for the separation of isotopes. The appealing point is that the separation factor of such a system is a function of mass difference of the isotopes being studied rather than a function of the square root of the ratio of the masses as is true in a gaseous diffusion system for isotope separation. This was probably the basis for the establishment of a Soviet research program on centrifugal separation of isotopes.

As favorable as this system may seem, the separation factor is not only a function of the mass difference but also a function of the kinetic energy of the isotopes due to the angular momentum developed in the ultracentrifuge. Since the mass difference or mass ratio is so small in the case of the isotopes of uranium it is necessary that an extremely high angular velocity be developed in any ultracentrifuge to be used for separation of these isotopes. The attainment of such extreme angular velocities caused much difficulty through rotor disintegration. Estimated rates required for efficient isotope separation ranged from a very low initial test rate to a maximum of 150,000 revolutions per minute. A rotor turning at the latter rate would disintegrate. In addition, nodes of vibration are passed in getting up to this speed which could be totally destructive if an imbalance existed in the revolving tube. The initial rotors constructed by the Steenbeck group were made by winding metal foil strips around a removable core. The strips were wound at an angle to the axis of rotation of the core. Each layer was soldered and a total layer thickness was built up until a layer 0.2 millimeter thick was constructed. The rotors were 400 millimeters long and had an outer diameter of 50 millimeters.

The rotor of the first centrifuge constructed by the group was driven by a specially constructed gear train. The motor used in this apparatus had an operating limit of 5,000 revolutions per minute. The gear train was so constructed as to impart at maximum a rotation of 80,000 revolutions per minute to the rotor. Various metal foils were used in making these tests; among them were copper, brass, nickel, aluminum, chromium, silver and gold. The critical velocity was found to be approximately 100,000 revolutions per minute. The research group was unable

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Figure 4

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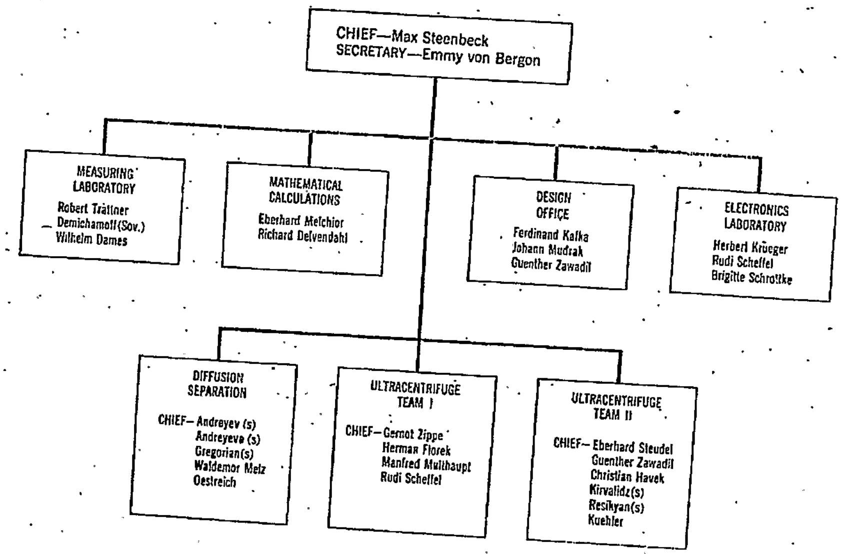

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to accomplish the desired velocity with the gear train for driving the centrifuge and a different type drive had to be developed.

A special aluminum alloy was developed for manufacturing more durable rotors. The composition of this alloy is unknown but it was a form of duralloy (duraluminum). This alloy was cast into ingots and these ingots turned to a length of 400 millimeter and an external diameter of 50 millimeters. The inner diameter was approximately 47 millimeters thus providing walls 1.5 millimeters in thickness. Although these new rotors would permit a higher rotational velocity, the motor driven gear train would not provide higher velocities. Therefore, a different drive system had to be developed and a high-frequency drive system was adopted. Small permanent magnets were attached to the inner surface of the rotors. The rotors were then driven by a high frequency current being passed through a continuous winding which was wrapped around the rotor chamber. This drive system gave initial velocities of 130,000 revolutions per minute but later developed a velocity of 150,000 revolutions per minute as a final velocity.

The attainment of such high velocities raised another problem. The heat developed caused ordinary type bearings to fail. A new type bearing to withstand the high temperatures was necessary. At first, an attempt was made to use regular type bearings providing extreme cooling by use of liquid air but this procedure failed. Other types of bearings used were teflon bearings, air bearings, and magnetic bearings. The degree of success achieved in any of these projects is unknown. There have been reports that the work of this group on the problem of magnetic bearings met with no success. A great interest was shown by the Soviets in all work in which teflon was involved. Nothing is known of the work on air bearings.

The initial work with the centrifuge was conducted on a "batch" basis but later in the program the research was changed to place more emphasis on the continuous feed process. Steenbeck apparently had a difficult time explaining his many failures to the Soviets although he did manage to keep the assignment within his group.

In the fall of 1952, the key personnel of the Steenbeck group were transferred to Leningrad. This group is rumored to have worked on the mass production of ultracentrifuge. Since Steenbeck underwent major eye surgery it is doubtful that he continued his research after leaving Sinop.

The Steenbeck group remains (1956) in the Soviet Union and no information is available on the activities of the group after their move to Leningrad. The final disposition of the project is therefore not known but most of the information available to us indicates that the ultracentrifuge was never adopted as a production means of isotope separation. The Steenbeck group probably made no substantial contribution to the overall success of the Soviet atomic energy program, other than to vigorously investigate one possible means of isotope separation.

Research at Sinop During the Period October 1952 - March 1955

Some of the research groups set up at Sinop after the beginning of the cool-off period, and their assignments are:

Mitrenin's Laboratory.--The derivation of pure germanium and silicon was studied by Mitrenin, Engalhardt, and Rexer.

Metallurical problems were studied by Riehl and Hepp.

Radiation stability of metals and plastics was studied by several Soviet scientists.

Migulin's Laboratory.--Cyclotron study of acceleration of fast particles was done by Kapkov. The construction of high-frequency generators was done by von Oertzen.

Chkuaseli's Laboratory.--Magnesic separation of petassium isotopes was done using a modified cyclotron. This was the cyclotron formerly used by von Ardenne, Froehlich, Bernhardt, and Schmal.

Isayev's Laboratory.--This laboratory worked on the development and construction of a scintillation counter. Critical measurements of electron multipliers were done by Herman Berhnardt, Schmal, and Schuber. The development of a detector for Hartmann was done by Berhardt and Schmal.

The development of the boron trifluoride neutron counter tube was undertaken by Schuber.

The development of a dynamic electrometer and a tritium measuring set was pursued by Romanov and several other Soviets. Romanov had a very imaginative mind; he started many projects but finished none.

During this time, Zimmer, assisted by Waschlun and Rosmann (Soviet) worked on the development of a scintillation dosimeter and a pocket ionization chamber for alpha, beta, and gamma radiation measurements. Efforts to develop plastic scintillators led to a study of radiation effects on insulating properties of plastics.

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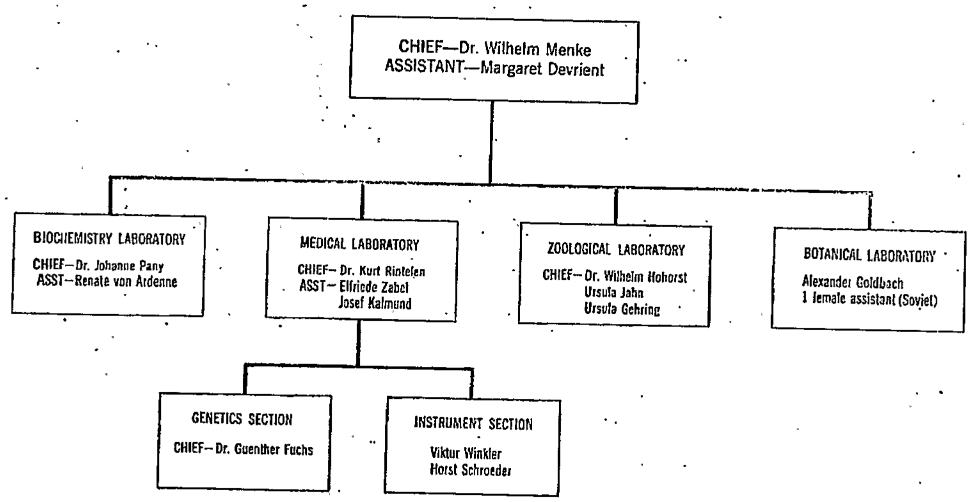
Figure 5

ORGANIZATION OF BIOLOGICAL DEPARTMENT, SINOP INSTITUTE



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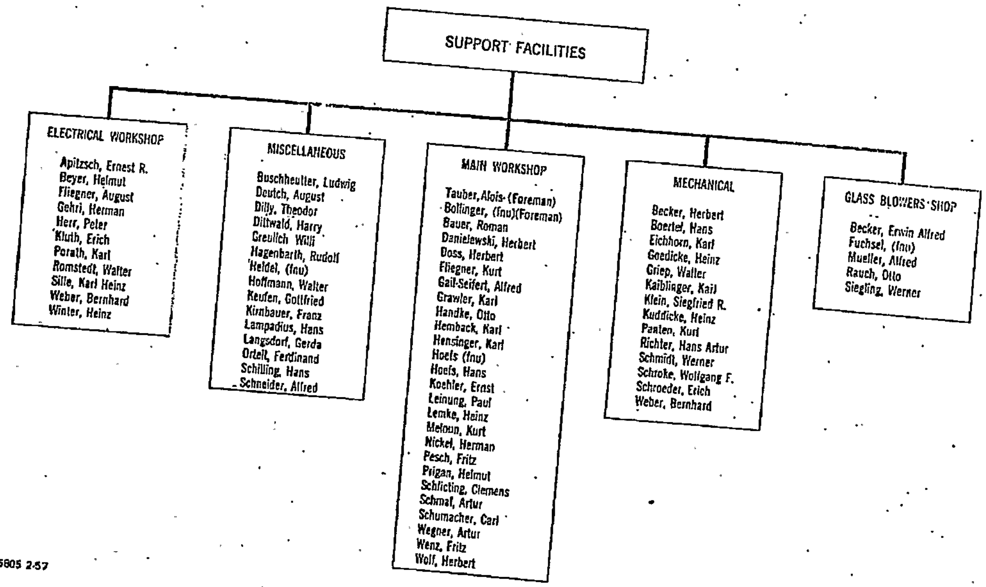
ORGANIZATION OF SUPPORT FACILITIES SINOP INSTITUTE

Figure 6



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Ion Source Development Projects at Sinop

When the Germans that had been sent from Sinop to Elektrosila, Leningrad, to work on the development of the ion source and its applications returned to Sinop, they were set to work on many minor projects. As has been mentioned before, one such project was the development of the "proton gun", presumed to be for use in high energy accelerators.

In 1951 orders were given for the designing and constructing of a high-voltage installation capable of producing 100 kilovolts and 100 milliamperes and designed for continuous operation. This order was given at the same time as the order for the development of the "proton gun". Froehlich and Rudenko built a small experimental model of the proton gun. The capacity of this source was a positive current density of five amperes per square centimeter. After the high voltage installation and the sourse was complete, von Ardenne, with Repin and Demikhanov, conducted many experiments using the completed apparatus. The final version of the proton gun was delivered to Kurchatov in Moscow in the summer of 1953. This model had the following specified ratings:

a. Emission aperture	1 mm^2
b. Total positive current	100 milliamperes
c. Proton increment	80 percent
d. Cathode life	20 hours
e. Efficiency factor	100 percent

It was later determined that the proton increment was only 25 percent and that there were actually very few protons present.

With these developments, the requirement for a long-life gas discharge cathode became apparent. Froehlich was given the assignment of developing such a source. The final version was presented in the summer of 1952 and had the following characteristics:

a. Evaporation rate	10^{-7} mass grams per hour
b. "Penning" discharge	1.3 amps, 20 volts
c. Main discharge	2.8 amps, 120 volts.
d. Source life	250 hours

Upon the completion of this proton source, this phase of the experimental work was abandoned.

Other items of this same general nature upon which the Germans worked at Sinop during the period from 1950 to 1955 were:

a. Continuously operated ion source
b. Collector system for the continuously operated ion source
c. Ion source for the production of triple and quadruple charged N-ions.

Operational characteristics of the multiple charged ion source, as finally presented, were:

(1)	Gas pressure	$6\text{-}7 \times 10^{-3}$ Torr
(2)	Arc voltage	750 volts
(3)	Arc current	80 amperes
(4)	Magnetic field strength	1000 oersteds
(5)	Pulse frequency	25
(6)	Pulse duration	100 microseconds
(7)	Gas consumption	10 cc per hour
(8)	Power input	1 Kilowatt

The value of this work toward the entire Soviet nuclear energy program is not known but in all probability it relieved the Soviet scientists of the necessity of conducting many long and laborious research tasks.

APPENDIX A

Soviet Personnel Identified at Sinop

Abshandadse
Electrical Engineer

Abshelava
Medical Doctor

Abzyanidze
Electrical Engineer

Agress
Mathematician

Alikhanov
Physicist

Andreyeshchev
Nuclear Physicist

Andreyev, Pavel P.
Physicist

Andreyeva, Anna Fedorovna
Unknown. Wife of Andreyev

Bokerev, Sr. Lt.
MVD Security Officer

Burdiyashvili, A.
Physicist

Chaprov, Ivan Mikhaylovich
Mathematician

Chkuaseli
Physicist

Chukhin
Engineer

Demikhanov, Ratch Aramovich
Electronic Physicist

Demirkhanov
Plasma Physicist

Demitriyev, Pavel Petrovich
Theoretical Physicist

Dubrov
Engineer

Fedorenko
Administration

Gorizontov, Boris
Admin. in charge of Special Materials

Forodnichenko
Nuclear Physicist

Grigoryan
Physicist

Gusev
Physicist

Guseva
Wife of Gusev, scientist

Gutkin
Theoretical Mathematician

Isayev, Ivan Mikhaylovich
Physicist - Administrator (Director)

Kakabadze
Chemist

Kapanadze
Administration

Kaprov
Physicist

Katkin
Electrical Engineer

Katov
Experimental Physicist

Kazsbaya
Electrical Engineer

Kervalidze
Physicist (Crystals)

Khelaya
Electro Physicist

Khromova
Physician

Khulilidze, Dimitri
Nuclear Physicist

Kichigin
Engineer

Kirvalidze
Physicist (semi-conductors)

Kochlavashvili, Gen. (MVD)
Director of Institute

Kochnev
Nuclear Physicist

Konograi
Administrative Secretary

Kovalenko
Physicist

Krasnov
High Frequency Engineer

Kuzmin
Administrative Director

Lazarev
Electrical Engineer

Levchenko, Aleksandr
Chief of Personnel

Lobin
Mechanic

Lomadze, Eteri
Chemical Technician

Lordkipanidze
Administrative

Maksimov
Theoretical Physicist

Mashtakova, Nina Karlovna
Chief Librarian

Migulin, Vladimir Vassilyevich
Electrophysicist (Director)

Mikheyev, Ivan Ivanovich
Chief of MVD Unit at Sinop

Mitrenin, Boris Petrovich
Physicist (Solid State)

Oganisyan
Unknown

Orlov
MVD Escort

Oziashvili, Yelena D.
Scientist, Unknown

Petrov
Mechanic

Pribitikov
Designer

Prokudin
Chemist

Rasvin, MVD, Col.
Administrative Chief

Repin
Physicist

Resigyan
Physicist

Romanov
Physicist (High Frequency Specialist)

Rozman, Josef Mironovich
Physicist

Rudanovskiy
Engineer

Rudenko
Technician

Rudenkov
Unknown

Serogin
Administrative Secretary

Shchamba, Nadezhda
Laboratory Assistant (Physicist)

Shitikov
Mechanic

Shkualidze
High Frequency Specialist

Shuleshko, Sascha
(Aleksandr Trifilevich)
Administrative

Soifer
Chemist

Sokolova
Chemist

Topolin
Administrative Chief

Tyemnikov
Security

Viktorov, Darian
Physicist

Vlasenko, Valentin Pavlovich
Physicist

Volkov, Vladimir Volodya
Technician

Voznyuk
Design Engineer

Yelistratov
Electrical Engineer

Yelkin
Chemist

Yermolayev, Yulian
Technician

Zhokhov, Aleksandr Vasilovich
Mechanic

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