RESEARCH WORK UNDERTAKEN BY THE GERMAN UNIVERSITIES AND TECHNICAL HIGH SCHOOLS FOR THE BEVOLLMAECHTIGTER FUER HOCHFREQUENZTECHNIK; INDEPENDENT RESEARCH ON ASSOCIATED SUBJECTS

COMBINED INTELLIGENCE OBJECTIVES SUB-COMMITTEE

LONDON—H.M. STATIONERY OFFICE

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Report XV.	S/Ldr. G.C. Barker, Capt. J.M. Robson, F/L. W. Abson,	TRE. RRDE. TRE.
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CIOS Items 1 and 7
Radar
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REPORT I

Physical Dept. of the University of Strasbourg at Seefelden.

Investigators.	Mr. R.M. Whitmer, OSRD. Capt. M. Snowden, RRDE.
Date of visit.	June 8th 1945.
Director of Dept:	Dr. Egon Hiedermann.
Assistants :	Dr. Otto Brandt. Dr. Freund. Dr. Osterhammel. Herr Leuschrer.
Person Interrogated:	Dr. Otto Brandt.

Report: (i) Supersonics.

Dr. Hiedermann and his staff were originally at Cologne University but were moved to Strasbourg University when this was taken over by the Nazis. The evacuation to Seefelden was made in October, 1944.

Dr. Brandt had worked exclusively on supersonics during the war. His experiments were made in a water tank the walls of which were coated with absorbent material to give adequate damping. This material consisted of many rubber fingers about 1 cm. thick and triangular in shape. The base of the triangle which was against the wall of the tank was about 3 cm, and the fingers were about 8 cms. long. He referred to a department working on supersonics which had been located in the Bay of Danzig.

In peace time Dr. Brandt had worked on supersonics in both solids and fluids. During the war this work was applied to the supersonic directing of torpedoes.

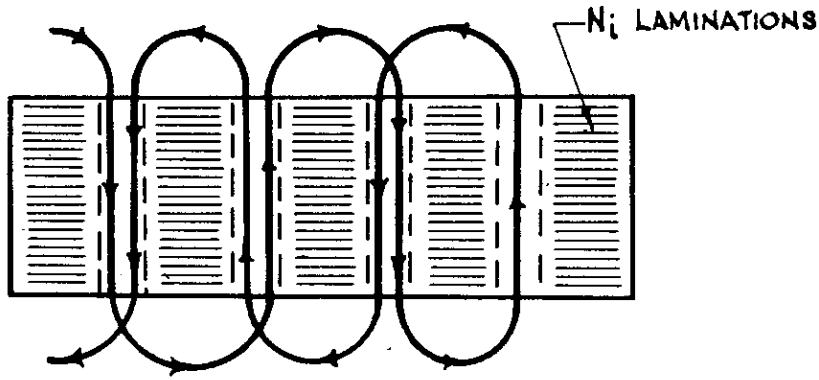
Impulse waves at a frequency of 80 Kc were transmitted from two antennae placed in the head of the torpedo. These antennae had a half power full beam width of 12° and were directed about 15° either side of the axis of the torpedo. Received reflections from the target were then arranged to steer the torpedo to the target as in normal Radar split beam technique.

Pulses were transmitted at the rate of 3 per second and two systems were being developed, one using short pulses of about 2oo microsecs. and the other using 20 m.sec. pulses. The working range

/of

of the homing system was limited to about 400 metres because of the repetition frequency used. No measurements of range however had been made as no experimental model was ever produced by this laboratory.

The transmitter was of the magnet strictive type and was driven from 80 watt amplifiers. The power output at supersonic frequency was not known. The size of the transmitter plate was approximately 8 cm. x 4 cm. as shown in sketch.



To obtain the necessary polar diagram the dimension of the plate is such that d/ = 4. The frequency used was 80 Kc/s. and separate transmitter and receiver plates were used. The plates used were built from laminations of pure nickel. The radiating assembly was very frequency-sensitive, only covering a band of ± 2 Kc/s.

A technique had been developed for modulating the pulses at a frequency of 1 - 4 Kc/s in order that an audio frequency instead of an 80 Kc/s amplifier could be used.

Brandt stated that no work on acoustic camouflage for ships had been done at Seefelden but that Dr. Meyer in Berlin had worked on this problem, the code name of which was Alberich.

Brandt also showed us some apparatus which was being developed by another member of the laboratory and about which he was not very conversant. It was designed with the object of studying the polar diagrams of microwave antennae by using supersonic models. A crystal bar of approximate dimensions 1 to 2 mms. square cross section and 3 to 4 cms. long was used as a line source. Behind this source could be placed various cylindrical reflectors. This radiator was immersed in a tank of liquid. When white light was passed through

/the

the tank in the direction of the long dimension of the crystal bar the supersonic beam appeared, outlined in colour. Colour photographic records of such beams were shown. It is not clear if the colour was due to dispersion or to double refraction.

REPORT II

CIOS PRELIMINARY INVESTIGATOR'S SUMMARY

TARGET NO. Opportunity

TARGET. Mathematical Institute, University of Tübingen.

LOCATION. Tübingen.

DATE. 9th July, 1945.

TYPE OF TARGET. Mathematical Institute.

CONDITION OF TARGET. Intact.

REPORT.

Professor K. Knopp, H. Kneser, E. Kamke, Dr. Wielandt, were interrogated.

(1) Prof. Knopp had not been connected with war research.
(2) Prof. Kneser had made calculations on the flutter of aeroplanes for Junkers (Prof. Hermann, Köthen) and DVL under a contract arranged by the Reichforschungsrat (Mathematisches Reichinstitute).

The calculations were of a routine nature (similar to those done under Prof. Walther of T.H. Darmstadt) and no new methods were developed.

Prof. Kneser had also begun some theoretical work on the calculations of the air forces on an oscillating aerofoil of finite thickness. One copy of the report was sent to Junker (Dessau) the other destroyed.

(3) Prof. Kamke carried out research work under contracts from RFR Arbeitsgruppe Mathematik. None of this appears to have any immediate bearings on any specific war work but all of it is extremely useful in any technical application of mathematics. For instance (a) His book on differential equations includes a collection of differential equations whose solutions are known explicitly. Volumes 1 & 2 have been published, volume 3 is in preparation.

(b) His manuscript catalogue of mathematical tables which was used by OKM and other agencies; we consider this less comprehensive than the Liverpool "Index" which has been prepared /by

by Prof. L. Rosenhead, Dr. J.C.P. Miller and Dr. A. Fletcher.

(4) Dr. Wielandt had been working at AVA, Göttingen, in the Institute for non-stationary problems (Prof. Küssner). In particular he had worked on numerical methods for solving flutter problems, and in the calculations of air forces at high subsonic speeds (using POSSIO's integral equation). Some of this work has been published in AVA or ZWB reports; but Dr. Wielandt stated that he intended to continue his work on flutter problems at Tübingen.

(5) Further action. No further interrogation of Prof. Knopp, Kneser and Kamke is considered necessary.

It was not possible to interrogate Dr. Wielandt in detail, and it is possible that detailed interrogation by experts on Flutter problems might prove of value.

Lt. Cmdr. John Todd, R.N.V.R.
Lt. Reuter, R.N.V.R.

REPORT III — CIOS PRELIMINARY INVESTIGATOR'S REPORT

TARGET — Mathematical Institute. T.H. Karlsruhe and Aachen.

LOCATION — Ummendorf b. Biberach (Württemburg)

DATE — 11th July, 1945.

TYPE OF TARGET — Aero-dynamic Research Centre.

CONDITION OF TARGET — Intact, but most of the equipment stored in boxes as the building had been requisitioned for some time.

REPORT

Personnel interrogated:

Prof. R. Sauer (T.H. Karlsruhe, Inst. of Mathematics - formerly T.H. Aachen).
Prof. W. Fucks (T.H. Aachen, Institute of Physics).

Prof. Sauer has been concerned with:

(1) External ballistics: calculations of trajectories by numerical methods, and by a differential analyser constructed by Askania (Berlin). This machine had been destroyed by bombing, but reports and drawings are available.

(2) Supersonic flow: Calculations of the air flow about projectiles at supersonic speeds, carried out for Peenemünde and RLM; calculations of the flow through nozzles were also carried out.

Prof. Sauer has also written a book called "Einführung in die Theorekische Gasdynamik" (Springer 1943) which deals with stationary problems; a second volume on non-stationary problems is complete in MS form.

(3) Subsonic compressible flow. An iterative method (first suggested by Göthert - DVL) for calculating subsonic compressible flow about an aerofoil, had been developed. Some numerical tables required for such calculations had been partly computed, but are incomplete.

(4) U.W. Explosions.

Some calculations on underwater explosions have been carried out. Prof. Fucks had been concerned with various experimental researches; equipment, for studying turbulence of fluid flow had been developed under a contract from the RLM. The apparatus /consisted

consisted of a pair of electrodes with a PD of several KV across them, so that a silent discharge takes place, the discharge current varies with the speed of the air flow past the electrodes. In this way, the turbulent variations of air speed can be shown directly on a CR oscillograph.

Research had also been carried out on electric discharge in gases. (especially breakdown of a gap) on equipment for measuring MV of guns, and on short electric shocks 10^{-6} secs. or shorter.

(5) Further action. No further investigation of this target is considered necessary. Prof. Sauer's work is published in ZWB reports, (U.u.M and F.B.) and reports on Prof. Fuck's work are also available. Prof. Fuck's apparatus for studying turbulence can be inspected at Ummendorf.

The first and second editions of Prof. Sauer's book on Gas Dynamics are out of print, a third edition is ready but has not been published. The second volume (non-stationary problems of gas dynamics) is almost ready in MS form. In view of the absence of any similar book in English, and the growing importance of the subject, it is suggested that an English translation of both volumes (suitably revised to include Allied work inaccessible to Prof. Sauer) should be prepared.

It is also for consideration whether the tables for calculating subsonic flow should be completed by Prof. Sauer.

Lt. Cmdr. John Todd, R.N.V.R.
Lt. Reuter.

REPORT IV. KONSTANZ TARGETS

Work of Dr. Gebauer, of the Physical Institute of University of Darmstadt.

Dr. Rudolf Gebauer, and his assistant Herr Kleestadler, were interviewed at No. 10, Alpenweg Strasse in Konstanz by a sub-section of the CIOS, Group 1 team under Col. R.E. Burns, U.S.A. on May 17th to obtain the technical details of his work.

Introduction.

Dr. Gebauer had worked under, and later with, Prof. Rausch von Traubenberg in the University of Prague on atomic physics; in particular he worked on the Stark effect, using very high electro-static fields, for instance 1.4×10^6 volts/cm. The two men continued their work in Kiel where Rausch von Traubenberg took a chair in the University of Kiel. In 1937 Gebauer changed to using h.f. electric fields and this led him to the development of a high voltage V.H.F. oscillator, independently of Heil but at about the same time.

Because Rausch von Traubenberg had a Jewish wife (who was a very talented scientist) he was not allowed to teach any more in Kiel, so both he and Gebauer went to Lorenz as consultants, their work being on the theoretical aspects of the iconoscope (Lorenz were anxious to get good scientists on this work as they were afraid Germany was getting behind America in television). In 1939 they had to separate and von Traubenberg went on to neutron physics on the private estate of Count/Baron? Waldstein later to finish up in a concentration camp with his wife. Von Traubenberg is now dead.

When the war started in 1939 Gebauer left electron gun work and was put in charge of the Lorenz velocity-modulated tube development (May 1939 to May 1941). In May 1941 he was elected to a chair in the University of Darmstadt, in charge of the work on atomic physics.

Dr. Döring took over from Dr. Gebauer at Lorenz, and Dr. Gebauer's assistant in Darmstadt was Dipl. Ing. Heinrich Steul. It is understood that Steul has been interrogated by CIOS teams at Heidelberg.

When Darmstadt was evacuated Dr. Gebauer and another assistant (mathematician) Kleestadler found shelter in this house in Konstanz where he occupies two small rooms as laboratory-cum-living rooms.

His present work on Heil tubes is entirely independent of any other organisation, but the Kriegsmarine, to whom he occasionally

/submitted

submitted results of his work, sometimes granted him small financial assistance. His total annual grant for research equipment by Darmstadt was only 1800 RM.

TECHNICAL DETAILS.

Dr. Gebauer's main aim was to improve the efficiency of Heil tubes on any convenient wavelength. When a reasonable efficiency had been obtained they would then aim for high powers, short wavelengths and wide bandwidths. Gebauer has derived a theoretical efficiency limit of 60% (excludes heaters). This is about the same as for Klystrons, but he claimed the Heil tube was simpler as it needed no high voltage supply and had only one resonator (He appeared to know nothing of reflex Klystrons).

It was claimed that he had actually measured an efficiency of 50% with a power output of 50 watts using a single slot gun designed for a fixed frequency of 25 cms. The highest frequency so far for which a high power tube has been built is 10 cms : 50 watts was obtained from this single slot tube at 25% efficiency. A smaller test oscillator has been built for 8 cm. and Dr. Gebauer saw no reason why he should not be able to go below 3 cm. if that was required since the limit would be set only by mechanical clearances.

Greater power outputs can be obtained by increasing the number of slots (half wavelength apart) at the expense of increased length and decreased bandwidth.

Dr. Gebauer thought 2% frequency modulation would be possible by varying the DC voltage, though this has not been tried.

Lower efficiencies than calculated are obtained with the tunable versions largely due to losses at contact surfaces. Contact plungers were employed. One such tube, seen on the bench connected to the vacuum pump, gave an efficiency of 15-20% over the range 22-32 cms. The DC voltage was 300-600 v, and a small magnetic field was used for focussing.

While it was obvious that considerable ingenuity and skill had been shown in order to construct the equipment and make the measurements, no new techniques were observed. Power measurement was by means of a load lamp containing very short tungsten wire, and a calibrated photo-cell.

Herr Kleestadler discussed the material he was preparing for his doctoral thesis, which permitted fairly rapid computation of the dimensions and voltages of the Heil tube for optimum efficiency by a semi-graphical method: the treatment was for small amplitude

/oscillations

oscillations only and no account was taken of space charge.

CONCLUSIONS

This small team, with very few facilities and little money has been doing commendable research on Heil tubes, but has made no outstanding contribution. Dr. Gebauer knew nothing of what was being done in the field of velocity-modulation tubes in Britain and the U.S.A., and seemed out of touch with the research projects which were being done in other establishments in Germany.

W.E.J. FARVIS (S/Ldr.)

REPORT V — CIOS INVESTIGATOR'S PRELIMINARY REPORT.

TARGET NO. — Opportunity.

TARGET. — Mathematical Institute, T.H. Darmstadt.

LOCATION — 32, Fichtestrasse, Darmstadt and various dispersal stations.

DATE — 29th June, 1945.

TYPE OF TARGET — Mathematical Institute.

CONDITION OF TARGET — The Institute in the T.H. Darmstadt was destroyed by bombing but most of the equipment had been previously removed to dispersal stations where it was intact.

REPORT

During the war Prof. Alwin Walther developed his small department into a large computing institute which employed some 90 people. This was apparently the only organisation of its kind in Germany and consequently there were many contacts with war departments. The Institute was divided into groups:

(1) Drs. Zurmühl, Unger and about 30 Junior staff.
This group worked largely for Peenemünde and carried out the calculations of the trajectories for the V2 (A4) and the A9 (some theoretical work on the accelerometers was done by Prof. Walther). A certain amount of flutter calculations for several firms was also carried out by this group.

(2) Dr. Hoffenberg and about 8 - 12 Junior staff.
Miscellaneous calculations e.g. routine normalisations of wind tunnel measurements for DVL were carried out by this group.

(3) Dr. Schöbe, Mr. Selow and about 12 junior staff:
This group dealt with the more mathematical computations including

(a) work on propagation of electromagnetic waves for Telefunken.
(b) Computation of Bessel Functions for OKM.
(c) Evaluations of lattice sums required in waveguide theory for Telefunken.
(d) Calculations required in a theory of waveguides developed by Buchol for LFS Heidelburg.

/(e)

(e) Numerical results for a theory of propagation of electromagnetic waves in a medium (where the dielectric constant was varying linearly).

(4) Dr. De Beauclair, Dipl. Ing. Dreyer and five mechanics: This group were engaged in the design of and construction (in conjunction with the Firma Dr. Ott, Kempten in Allgäu) of a differential analyser based on the integraph of Abdanke-Abakanowitz in which photo-electric curve followers and electric coupling of the units were employed.

(5) Dr. Czerniakorski and about 20 junior staff: The group carried out administrative work and miscellaneous computing. In particular, pursuit curves for guided torpedoes, evaluation of various methods for solution of large systems of linear equation (e.g. by punched card machinery) trajectors for "Wasserfall" (ar. A/A radar controlled rocket) ballistic tables for 88mm A/A guns for arctic conditions, propagation of sound in a stratified medium.

(6) It would appear desirable to provide facilities for the completion of certain pieces of tabulation of general scientific interest e.g. those of Bessel functions which had been planned in Great Britain some twenty years ago but of which only isolated ranges have been completed during the war.

Lt. Cmdr. John Todd, R.N.V.R.
Lt. Reuter, R.N.V.R.

REPORT VI CIOS INVESTIGATOR'S PRELIMINARY REPORT.

TARGET NO.	Opportunity
TARGET	Prof. Lothar Collatz
LOCATION	T.H. Hannover: at present, Kleist Str.9, Karlsruhe.
DATE	26th June, 1945.
TYPE OF TARGET	Mathematician
CONDITION OF TARGET	Reasonable.

REPORT

Prof. Collatz is one of the leading experts in the field of numerical applied mathematics and as such had been engaged in research and development throughout the war; he worked for various agencies, notably the Reichforschungsrat through the Mathematisches Reichsinstitut.

A valuable survey of the numerical methods for treating problems of vibration was prepared by Prof. Collatz in book form. It appears that 2,000 copies of this book was printed and are known to have reached the binders, E.O. Freidrich, Leipzig, on 6th March. A copy of the proofs of this book have been inspected and it is considered to be of considerable value to mathematical technologists, e.g. in aircraft industry. While it would be of value to obtain at least a part of the German edition it may be desirable to prepare an English edition by translating the German one and supplementing it where necessary by accounts of Allied work, so far inaccessible to Prof. Collatz.

A further book is in preparation by Prof. Collatz. It is entitled "Numerical treatment of differential and integral equations". It is for consideration whether the facilities for the completion and publication of this book should be granted - a similar work had been contemplated by Admiralty Computing Service but had not progressed beyond that stage in view of other more urgent commitments.

Lt. Cmdr. Todd, R.N.V.R.
Lt. Reuter, R.N.V.R.

REPORT VII — INTERROGATION OF PROFESSOR W.O. SCHUMANN OF THE ELECTRO-PHYSICAL LABORATORY, MUNCHEN UNIV.

Located at home address, Wörnsmühle, near Miesbach, S of München.
(Map reference M48/200)
Investigated by Capt. E.T. Ramm, C.I.O.S. Group 1,) and Sgt.E.Mayne.
F/Lt. L.B. Mullett do. do.)
Date of investigation 15/6/45.

Professor Schumann is an extremely able theoretical physicist and has been making a study of pulse generating networks, discharge in gases and work on gas tubes, plasma oscillations, the periodicity of concentrations of ions and electrons in gas discharge.

Some of his recently published papers were obtained, as follows:-

Uber Plasmalaufzeitschwingungen--- Zeit. f.Phys.7/1942.
Uber raumlich periodische Verteilungen frei fallender Ionen und Electronen ---- Zeit. f. Phys. Feb.1943.
Uber Stabilisierung des gesteuerten Vakumsbogens und die Bogenskonstanten---- Zeit. f.Phys. Feb.1943.

Important fellow workers of Schumann are:-

Dipl.Ing. Nauer in charge of lab. at Neumühle.
--Höss plasma oscillations.
Dr Haug do. do.

Professor Schumann is extremely cooperative, and is violently anti-Nazi. This is confirmed by Prof. Piloty, also of München. They both express very strongly that the Nazi elements must be removed from their institutions and that they are both joining the new Ministry of Education in München.

The work of Schumann.
Pulse Generating circuits.

Dr. Schumann has been working on this problem for a long time, and had obtained from the BHF a contract to continue this work. The specific terms of the contract were to reduce the number of components needed in the pulse forming network, and to generate 1 Megawatt pulses with very fast leading edges, various linear rates of rise of the top of the pulse, and various lengths (of the

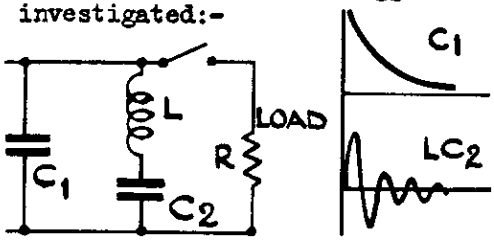
/order

order of 1 microsec.).

(a) Conventional LC delay line open circuited. This was not regarded with favour because of the large number of components required to stand high voltages.

The lines were designed for low voltage, high current working, and the output transformed to feed the transmitter (magnetron) with a pulse transformer of about 4/1 ratio.

(b) At the suggestion of BHF, the following circuit was investigated:-



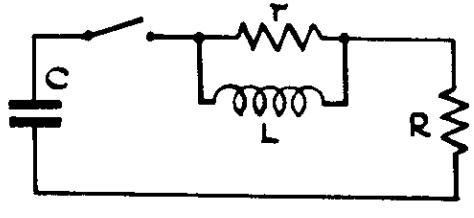
The basis of the idea was to superpose the exponential decay of C_1 on the oscillation of LC_2

This was proved both theoretically and practically to be useless because of the large coupling between C_1 and C_2 through R, resulting in an exponential with a slight ripple due to the oscillating circuit.

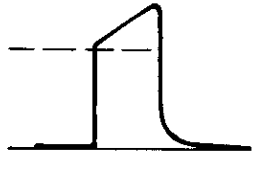
The period of oscillation was always found to be $\frac{1}{L\theta_2}$,

i.e. independent of R.

(c) The ideal circuit was as below:-

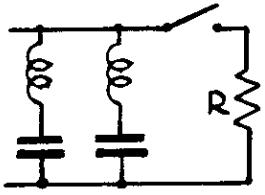


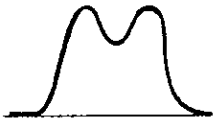
All the conditions could be satisfied so as to obtain a very good pulse



For a flat top it was found that $r^2 = \frac{L}{C}$, independent of R.

(d) Two series resonant circuits in parallel were also tried.





With low coupling between the two circuits a normal bandpass curve should be obtained.

This behaviour involves R being very large. With the actual values of R the mutual coupling is so large that very slow rates of rise were obtained.

This work was not published but a typed copy of all the theory was obtained. This gives full calculations of pulse shape and length, efficiency of circuit, &c. The theory had also been proved experimentally within limits determined by the quality of the condensers and inductances used.

Gas Discharge tubes and stabilisation.

Professor Schumann has done a considerable amount of work on gas tubes, and in particular has very intensively investigated the application of negative feedback with the various conventional circuits (and many other arrangements) in order to achieve a linear decrease of current by grid control instead of the usual sharp cut-off.

---Ref. Uber Stabilisierung des gesteuerten Vakuumsbogens und die Bogenskonstanten, Archiv für Elektrotechnik, 36 Band, 1942, 6 Heft.

Dr. Medicus had for some time worked on a corona discharge tube for stabilisation of voltages up to 10,000 volts (mainly for klystron operation). This work was dropped in favour of neon stabilisers in production at Phillips.

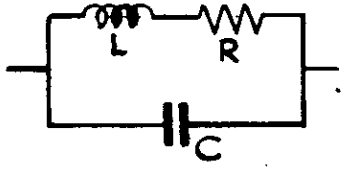
/Oscillations

Oscillations in Plasma.

The Professor and some of his students had done a considerable amount of work on this subject, and had developed equivalent circuits for the phenomena.

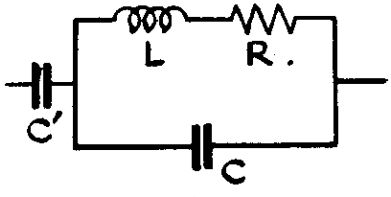
Mr. Höss had worked on the generation of H.F. using plasma oscillation in the neighbourhood of 30cm. It was found that with currents of the order of a few miliamps, oscillation was obtained, but all the attempts to increase the current so as to obtain more power always resulted in cessation of oscillation. This was aphenomena well known to plasma oscillation workers but so far it is absolutely unexplained.

The normal oscillation is due to a parallel resonance equivalent circuit consisting of:-

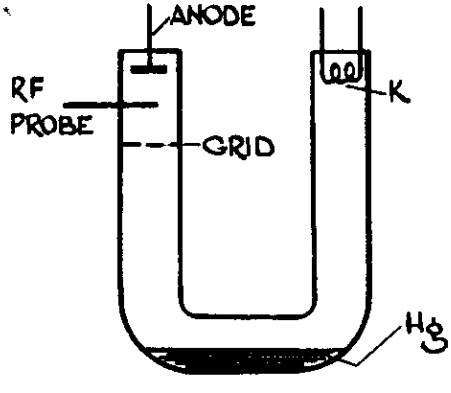


L - representing the mass of the electron.
R - " " electron resistance
C - " " geometric inter-electrode capacity.

Dr. Haug had very recently proved the presence of a series resonant circuit (theoretically and experimentally) formed by the addition of C'- the capacity due to the ion sheath on the grid.



The experiments were carried out in a U- tube with R.F. power being fed into the plasma between a probe and the anode so as to form the termination of a lecher line. The R.F. impedence of the plasma was then measured at various frequencies and the resonances ploted.
Dr. Haug is at present preparing a summary of this work (it will be added later).



Students of Prof. Schumann had also carried out some interesting experiments to determine the nature of GAS DISCHARGE phenomena at low pressures e.g. Hg. vapour at 10^{-3}mm.

Dr. Bullinger in particular had found that the discharge was very similar to high vacuum discharge with the presence of +ve ions only slightly modifying the electron behaviour. In one particular Hg. vapour tube the positive ion sheath on the grid had accelerated the electrons to 500,000 volts, and after focussing the beam with a coil, photographs of the grid were produced. The data obtained from these experiments had been used to calculate mean free paths etc.

Direction Finding problems.

Some work had been done for the Navy on the electrometer method. Dr. Schumann's laboratory produced 4 and 8 segment electrometers of very high sensitivity.

One of the major problems was drift of the DF minimum which was thought to be due to aerial interaction, but it was impossible to establish this experimentally.

Work had also been done on methods of introducing sense into the system, both with artificial targets and by producing asymmetry artificially by loading one of the segments with a capacity to earth.

Professor Schumann is now engaged in writing new textbooks for students returning to the Universities.

REPORT VIII INVESTIGATION SUMMARY.

1. Target Number or Disignation CIOS 03.

2. Name of Target. Electrical section of Technical High School, Brunswick.

3. Type of Target H.F. Work.

4. Location. Brunswick.

5. Date of Investigation. 4th June, 1945.

6. Physical condition of target. 10% damaged, much of equipment dispersed to Wedden 10 KM away - 50% of this now brought back, rest looted at Wedden.

7. Investigators:

NAME	RANK	ORGANIZATION	AGENCY REPRESENTED.
O.L. Ratsey	Cdr.	A.S.E.	CIOS CAFT 1
W. Abson.	F/L.	T.R.E.	" "

8. Resume of Intelligence gained by Investigator:

(1) Summary. The Technical High School at Brunswick, under the direction Prof. Gerstenburg, covered many fields. The Electro Technics dept. was itself split into three sections:-

High voltage work dealing with transmission of power over a distance, was under Prof. Marx.

Electrical Machines were dealt with by Prof. Ungar.

High frequency work was under Prof. Pungs (1st assistant Dr.Lambert).

A Captain Roberts had carried out some investigations in the first two departments. The present investigation deals only with the High Frequency Work (assessed by F/L Schofield) and will be considered under the following headings. N.B. The H.F. work was done largely at the instigation of the Navy organisation N.V.K. (Nachrichtenmittel Versuchs Kommando).

(1) Aerials. Wideband in 1m. to 2m region. Circular Polar diagram in horizontal plane with horizontal polarisation.

(2) Simple Jamming Transmitters. Resonant circuit with spark gap (Aluminium electrodes in air) Wavelength in 2 metre region.

(3) Measurements on Insulators in 50cm, 2m region. All records and reports still held by the T.H.S. were destroyed by order before Town captured.

(4) Measurements between 20cms and 6 cms on insulators, conducting sheets when placed in front of perfect conducting sheet with view to investigate reduction of reflected energy (i.e. radar camouflage). Measurements in same band of reflection from various soils, grass water etc., investigation was not complete - detailed records were destroyed - not possible to get any general conclusion from Dr. Lambert. He said work had not progressed far enough for that.

The T.H.S. started this "war time H.F. work" about the beginning of 1943, beginning with the work on aerials. The following more detailed statement is based on an interrogation of Dr.Lambert.

1. Aerials - (a) detailed investigations had been made on a single dipole radiator for the band 1m to 2m. Some work was done on 'fat dipoles' but effort was concentrated on flat discs as the elements of the dipole. The work is summarised by the diagram and chart in Figure 1 attached. An accurate copy of the impedance plot was obtained from Dr. Lambert's laboratory handbook.

(b) A further problem from the Navy was to produce a broadband aerial with a circular polar diagram in a horizontal plane, with horizontal polarization. What was called a 'reasonable solution' was obtained by using two circular disc dipoles, each one having its elements bent at 90 degrees to each other. Perspective sketch attached, see figure 2, and plan, figure 3.

Measurements on a model using 44cm diameter discs were made from 120 cms to 200 cms. The P.D. was circular at 172 cms and was ellipsoidal for wavelengths on either side.

At 200 cms	$\frac{E\ Max}{E\ Min}$	equals	1.26
at 154 cms	"	"	1.17
at 120 cms	"	"	1.65

The broadband nature as regards impedance was not as good as with a single 'in line' pair of discs. The impedance plot was of the same form. The value of R in the electrical half wave condition was still 40ohms but in the electrical full wave condition R had risen to about 450ohms.

/2.

2. The T.H.S. were asked to develop an extremely simple form of jamming transmitter. They worked on a Hertz type spark relaxation oscillator of the well known form. (see attached diagram figure 4). With conditions as seen in diagram, a mean power of 4 watts was obtained so long as aluminium electrodes were used. With other metals (brass, copper, etc.) the frequency of the 'bursts' of oscillations fell considerably. This was not fully understood - it is apparently connected with de-ionisation time. No information on life of the gaps was available except that aluminium oxide formed and the number of pulses per second was then reduced.

Only experimental samples were made, and these used electrodes of about 1/4 inch diameter, the spacing being adjusted for optimum mean power.

(c) Work had also been done on a rotating beam listening aerial, again in the 1m to 2m band. 24 dipoles were arranged along the circumference of a circle 2.7m. in diameter. Three only of these were fed at one time, and a rotating capacity device was used to switch to any adjacent three dipoles.

(d) Measurements of phased arrays using up to 16 elements of the time described in (a) above, were also made at the T.H.S.

3. No further details can be added to statement in summary.

4. Measurements on 20 - 6cms. in connection with radar camouflage. A considerable effort had been necessary in order to make the apparatus (including tubes!) for measurements in this region. There was nothing of outstanding interest in this equipment however.

Dr. Lambert was fully conversant with the impedance concept in regard to transmission in free space and with the method of matching a Plane wave into a 'short circuit' (perfectly conducting sheet) by the use of resistive surface layers with graded values of ohms resistance per square. Measurements had been made between 20 cms. and 6 cms. using about five layers of 'semi-conducting' sheets occupying a total depth of about 10 cms in front of a metal sheet. The reflected signal was of the order of 10-15% of that reflected by the metal sheet alone.

The conducting sheets had been supplied by N.V.K., who moved from Kiel to Wolfenbüttel (near Brunswick) in June 1944. The T.H.S. at Brunswick was in effect a subsidiary of this establishment.

The investigators' found in the files at G2, 9th Army HQ a report on this target (i.e. N.V.K.) and therefore did not pursue it further. Note - the investigation of N.V.K. was by Major Oxford, Major Caplin, F/L Snowden (TRE) and some others. Date 8th May, target 7/124.

CIOS trip 183.
REPORT IX.

INTERROGATION OF PROF.DR.ING. SCHUMANN OF THE UNIVERSITY OF MUNICH AT WORMSMUHL - 4/6/45.

Interrogated by S/Ldr. B.A. Sharpe.

Dr. Schumann was first interrogated about the work carried out under his direction in connection with interference caused to the reception of Radio Control Signals in Missiles, by noise generated by the propulsion gases.

Dr. Schumann stated thatthis work had been carried out for the RLM. He was told by RLM that the work must be of a practical nature as quick results were required. A theoretical investigation could be done later. Much of the experimental work has been done at Peenemünde by an assistant of Dr. Schumann (Mr. R. Prochaska). Mr. Protraska had written an account of this work and this manuscript was handed to the writer by Dr. Schumann. In addition however Dr. Schumann gave the following description of the work.

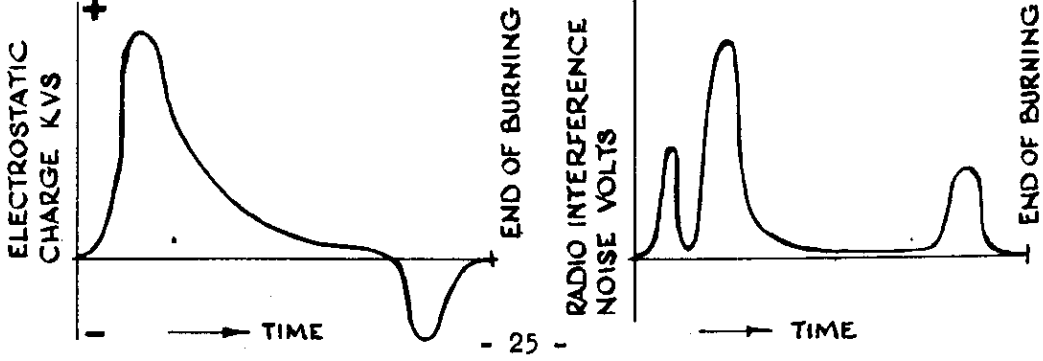
All the tests were carried out on the ground with the missile mounted on insulators. Two types of tests were made.

1) A microammeter was connected in series with the insulation path to earth and the potential produced on the missile due to the exhaust gas was recorded.

2) The noise voltage output of a Radio Receiver inside the missile was measured.

The tests had shown there was no consistency in the behavior with different fuels.

In general the potential and the Radio Interference were greatest at the start and end of combustion. The curves below show the type of results obtained with hydrogen peroxide and calcium permanganate.



With some fuels the charge was of opposite sign at the beginning and end of burning while with others it was the same sign.

With alcohol, Liquid oxygen system tests had shown that all of the interference was due to the fuels used to initiate the main combustion and that the burning of the alcohol caused no interference.

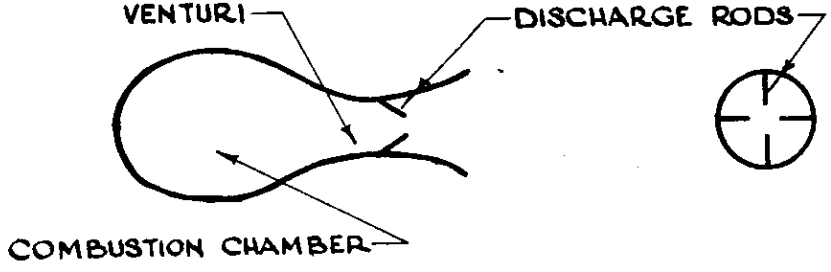
The ratio of fuel to ignitor also effected the amount of interference caused. It had been found with certain fuels that a particular ratio of fuel to ignitor gave minimum interference. Unfortunately however this particular ratio did not also correspond to that required for maximum propulsion efficiency.

The second factor that influenced the interference was the material of the surface of the Venturi. For instance if the Venturi is of iron and the fuels are potassium permanganate and hydrogen peroxcide it has been found that the interference can be reduced by covering the iron surface of the Venturi, with a layer of manganese dioxide. The interference varies with the thickness of the layer and at a certain critical thickness the interference was zero. At this point also the electric charge on the missile was also zero and changed sign depending on whether the thickness of the outside layer was increased or decreased from this critical value.

It should be noted that no direct relation had been found between electric charge and Radio Interference.

METHOD OF REDUCING INTERFERENCE.

Dr. Schumann then described a method that had been devised as a result of this work, which had been found to reduce Radio Interference to a very large degree.



A number of thin rods were fixed in the Venturi as shown, in the above diagram. These would have to be of material that would withstand the flame temperature but this had not proved insuperable.

/According

According to Dr. Schumann this method practically removed the electric charge and interference with all fuels.

For all controlled missiles the field strength of the controlling transmitter is high at the missile. In practice it had not been found that interference to the flame was of any importance. Dr. Schumann's report on this work has been passed to Lt.Col.O'Mara for inclusion in the report on the Garmich Target.

PLASMA OSCILLATION.

Questioned about other work that he had in hand Dr. Schumann stated the main interest of his laboratory was in plasma oscillations.

Plasma is the name applied to the luminous discharge columns in a gas discharge tube. Dr. Schumann had sought to control the discharge current by the insertion of a grid. At low frequencies the curve showing the relation between anode current and grid volts had shown that hysteresis existed.

As the frequency was increased however, the hysteresis became less noticeable and at frequencies of the megacycle region it did not appear.

The main advantage of the use of plasma oscillation was that large powers could be handled without the use of high anode voltages. Outputs of about 20 watts with HT voltages of 200 had been obtained.

The chief difficulty at present was the short life of the grid due to ionic bombardment.

The maximum life so far obtained had been 30 minutes.

Dr. Schumann has a number of papers containing record of work carried out by his students on this subject.

REPORT A

Prof. Gerlach, UNIV of Munich

Home address: Franz Joseph Str. 15/2 Gautenhaus

A member of the family reported that Prof. Gerlach was taken away on 3rd May by American Officers from a "Scientific Commission" and had not been heard from since then. A check at CIC showed he had not been arrested.

If further information is wanted we suggest contacting ALSOS in Paris.

AYSOS ?

?.?. Marion CIV
Capt. ?. Snowden [illegible]
Lt. P. ?. Reigert [illegible]

REPORT XI

(Univ. of Munich.- Prof. Piloty.)
Investigators.

Capt. Comr. R.T.S. A.D.E.
F/Lt. L.F. Hallett. T.R.E.
Sgt. F. Payne.

Date of Investigation June 16th., 1945.

Location of Prof. Piloty.- 49 Rosenkoffener Str.
Starnburg.
Nr. Wurmsee.

Report.

Prof.Piloty in general confirmed the report of Dr.Devons and party on the Lab. at Oberandorf. He provided a summary (in english) of the work and workers. This is in complete agreement with the report. He indicated which sections he regarded as important from a scientific aspect.

Prof.Piloty had been working for many years on problems dealing with filters and pulse forming networks using Tschebyscheff approximations to obtain maximum deviations less than any arbitrary value for any given filter. He gave many examples of this method.

Before the war Prof.Piloty designed a network to produce a pulse in the form of a gaussian error curve from a square pulse, the object being to reduce the frequency spectrum to a minimum. This was required for a time modulation communication system at Telefunken (Dr.Bayer working under Dr.Rosenburg?). The work was stopped in 1939 and Prof.Piloty had no knowledge of its being resumed.

REPORT XII

CIOS CONSOLIDATED ADVANCE FIELD TEAM REPORT

TARGET NO: 1/154

Universities of Konigsberg, Graz, Gottingen.

TYPE OF TARGET: High temperature ceramics and H_2 O_2, Far Infrared spectroscopic transmission measurements, high frequency dielectrics, de-icing for aircraft.

LOCATION: Passfeld: Lat 147° 3' Long E 13° 4'
Bockstein: Lat 147° 5' Long E 13° 7'

DATE OF INVESTIGATION: 5th June, 1945.

PHYSICAL CONDITION OF TARGET: Documents previously evacuated and equipment intact. Not guarded.

INVESTIGATORS: Lt. H.R. Marvin, Civ., USSTAF, CIOS
L.B. Bullet, F/Lt., R.A.F., CIOS
Mr. D.H. Hamsher, Civ., US Sig.Corps, CIOS

RESUME:

(a) The high temperature ceramic and H_2 O_2 work of the Univ. of Konigsberg was not investigated since it was not a Group I subject and the investigators were not qualified to cover it.

(b) Prof. Batossi of the Univ. of Graz stated that he had been making transmission and reflection measurements of dielectrics in the region of 2 to 20 μ, infrared absorption of H2O vapor, spectroscopic determination of hydrogen bonds in isomers of Oxy. - Naphtho-Säure-Methylester, investigation of use of pyroelectric effect in determination of temperature of sky. See attached list of projects. Prof. Borgnis was in a hospital and his assistant Liedeneg was in charge of cm wave measurements of organic and ceramic dielectrics. These measurements were made in 1944 at wavelengths of 14 cm as given in the attached list. For generating the high frequency power he used a Resonatron built by Pintsch of Konstanz. Resotank? Dielectric samples were tested for dielectric constant and power factor in cavity resonators in the H_{010} mode and coaxial lines. He also measured the permeability and power factor of mixture of rubber and powered iron for use in radar camouflage.

Sump

(c) See Insert.

List of equipment Guarded - None
List of documents Guarded - None
Personnel Guarded - None

Documents to be removed - None (Nielsen had already evacuated them)
Equipment to be removed - None by CIOS.

Recommend Target be cleared to ETI.

KARL-FRANZENS-UNIVERSITÄT GRAZ
ABTEILUNG FÜR TECHNISCHE PHYSIK
AM I. PHYSIKALISCHEN INSTITUT

1/54 Attestenent

(12a) Graz den 10. August 1954

Universitätsstraße 5
Fernruf 15-03, 15-73.

Liste der bei λ = 14 cm bestimmten Werte von ε' und δ tg

Klasse	Material	ε'	Zimmertemperatur 10^4 tg	Zimmertemperatur $10^4 \cdot \varepsilon'$ tg	250° 10^4 tg	350° 10^4 tg
Isolierstoffe	Plexiglas	2.5	52 - 65	130 - 163	-	-
	Bernstein	2.5	70	175	-	-
	Trolitul	2.5	5.7	14	17	18
	Mipolam	6.0	1150	6900	-	-
	Fiber	3.9	600	2340	-	-
	Trolit F	6.0	380	2200	-	-
	Troliten	4.0	550	2200	-	-
	Trolitax	4.0	500	2800	-	-
	Trolon	4.0	350	2800	-	-
	Opanole	2,3-2.5	3	6.9-7.5	-	-
	Igelith	2.3	3	7.5	-	-
	Pertinax	4.5	540	2430	-	-
Keramik	Frgan	4.2	19	80		
	Ardostan	5.7	64	365		
	Calit	5.9	10-20	59-118		
	Frequenta	5.9	12	71		
	Tempa S	13.0	7	91		
	Condensa C	80.0	20	< 1600	Verlustwinkel	
	Condensa F	80.0	20	< 1600	ändert sich nur	
	Porzellan	5.5	80-90	440-505	innerhalb der	
	$Ti\ O_2$	17	15	255	Fehlergrenzen	
	Be O	7.5	3	22.5		
	Al_2O_3	9.5	10	95		
	$ZrSi\ O_4$	8.9	60-70			
	Spinell	9.0	8	72		
	Sinterzirkonerde	20.0	7.14	140-280		

Klasse	Material	ε	Zimmertemperatur 10^4 tg	Zimmertemperatur 10^4 tg	250° 10^4 tg	350° 10^4 tg
	Benton	9.2	250.300	2300-2760	Verlustwinkel andert sich nur innerhalb der Fehlergrazen.	
	Quarz	3.7	3.5	13		
	Uviolgas	5.2	77	400		
	Supremay-glas	5.6	31	174		
	Magnesia-glas	6.5	70	455	-	200
	Jenaer Normal glas	7.1	100	710	-	-
	Jenaer Gerateglas	7.2	52	375	-	-
	Jenaglas 16 III	6.7	66	442	-	140 - 160
	Minosglas	7.5	25	188		35
	Resisto las	5.0	50	250	-	-
	Loosbrunner					
	Bleiglas	5.6	40	224	-	80
Wolfram-Einschmelzglas (Osram)	..31. 122p	6.4	36	230	90	120
	" 123a	6.0	80-90	480-540		200 - 220
	" 172a	6.6	31	212	50	60
	" 246b	7.1	90	268	190	250
	" 301b	7.9	20	158	45	50
	" 362b	4.4	45	198	90	135
	" 394b	6.5	41	267	80	120
	" 424d	5.4	56	302	125	160
	" 584d	6.6	30	198	50	70
	" 637h	5.1	42	214	60	80
	" 712b	4.8	45	216	-	120
	" 742c	6.1	40	244	-	120
	" 50 756b	5.1	50	255	-	150
	" 779a	6.6	38	251	60	80
	" 781	6.6	51	337	-	150

1/154 attachment

PHYSIKALISCHES INSTITUT
DER UNIVERSITÄT GRAZ
Universitätsplatz 5
Fernruf 13-65

Bockstein-Nassfeld 5.6 1945.

Bericht über die Arbeiten der letzten Jahre

1) Pyroelektrische Untersuchungen.

Es wurde der pyroelektrische Effekt auf seine Eignung untersucht, für Strahlungsmessungen zu dienen. An und für sich ist der Effekt empfindlich genug. Die thermisch bedingte Trageheit erschwert jedoch die technische Verwendung. Zur Messung der Strahlung ausgedehnter Flachen, etwa der Himmelsstrahlung, bietet dagegen der Effekt grundsätzliche Vorteile, da die Empfindlichkeit der Flache proportional ist.

2) Ultrarotes Spektrum des Wasserdampfs.

Für die Kenntnis der Strahlungsdurchlassigkeit der Atmosphare ist die Abhangigkeit der Absorption von Druck und Partialdruck von Bedeutung. Diese wurde experimentell bei 6 untersucht. Ferner wurde Hilfe aus den Beobachtungen von H.H. Nielsen die Druckabhangigkeit zu berechnen. Diese Rechnungen sind geeignet, die umstandlichen Messungen zu ersetzen. replace

3) Ultrarotabsorption und - reflexion von Isolierstoffen

Die bisher erzielten Ergebnisse an Plexiglas und anderen Stoffen sind zur Zeit im russischen Machtbereich unzuganglich.

4) Oxy-Naphtho-Saure-Methylester.

Diese Messungen wurden ausgefuhrt, um Wasserstoffbrucken bei verschiedenen Isomeren dieser Stoffe festzustellen. Die Untersuchung geschah in Zusammenarbeit mit der Firma Bata, Zlin, Tschechoslowakei.

Geplant sind:

1) Untersuchungen über die Schwingungen der Alkalihalogenide

Es handelt sich um Schwingungen, die den mm-Wellen entsprechen. Die Untersuchung kann mit der Methode des Ramaneffekts oder im kurzwelligen Ultrarot aus der Feinstruktur von Oberschwingungen durchgefuhrt werden. Die Ergebnisse haben voraussichtlich Bedeutung fur die Verwendung solcher Stoffe in der Technik der mm-Wellen. Die theoretische Berechung dieser Schwingungen ist in Angriff genommen.

2) Abbildungsfehler von Elektronenlinsen.

Ziel der Untersuchung ist die Frage, ob mit Hilfeelektronenoptischer Gerate ein Hohenmesser, bzw. ein Anzeige - und Steuergerat fur niedrige Hohen entwickelt werden kann, das fur Bodennebellandungen von Flugzeugen von Bedeuting ware.

Allgemein ist mein Institut in der Lage und dazu bereit, Messungen auf optischem Gebiet und im ultratoten Spektrum durchzufuhren. Wenn eine Arbeit auf dem Nassfeld nicht moglich ist, hielte ich es fur zweckmassig, mich einem anderen optisch ausgerusteten Institut anzugliedern, insbesondere etwa dem Physikalischen Institut der Universitat Tubingen.

Der Direktor:

REPORT XIII

To: Major L.Johnson Ferguson, T Branch G-2 12th A&P
Subject: CIOS Preliminary Report
Target: Technische Physik Institut, Jena
Date of Visit: 4th June, 1945
Purpose of Visit: To investigate reported wide band amplifier covering 24 cm ± 2 cm

General Results of Visit: The amplifier was not wide band in the sense that it had a flat pass band of 4 cm but had merely been designed to be tuneable over this range. The amplifier worked on the beam deflection principle and the designer hoped for power gains up to 1000. He claimed very low noise factor but had so far been unsuccessful in making the system operate completely as desired.

Narrative: Dr. Muller was interrogated in connection with this amplifier which is of the beam deflection type. A very high density well focussed beam of electrons is sinusoidally deflected by a set of parallel plates whose distance apart are so set that the transit time of an electron is the same as the period of the HF to be amplified- the HF being fed onto all the plates simultaneously. A beam is therefore produced which is deflected sinusoidally in synchronism with the incoming signal. This beam falls on the slit of a high Q resonant chamber tuned to the same frequency as the input signal and from which the output is taken. The system had never been made to work completely successfully, but theoretical considerations showed that a voltage gain of about 30 should be obtained at 4 cms. One point in favour of this system is the low noise factor which can be achieved if the initial electron beam is correctly focussed. Considerable work has been done on the electron optics of the system and a beam current of about 50 mA had been achieved with the necessary degree of focussing. This had mainly been achieved by careful design of the cathode system as shown in fig.3. First the principle of operation was investigated. For this purpose an electron beam was deflected by a pair of low capacity plates (as in a CRT) at a wavelength of 10 meters, and was projected onto a slit aperture in a condenser. This condenser formed the capacitative element of an LC circuit of the same wavelength as was used on the deflecting plates. The HF was modulated at 1 kc/sec and was monitored by a diode and amplifier. The adjustment of the well defined electron beam onto the face of the slit aperture of the working condenser was done mechanically and externally by displacement of the aperture. This adjustment is essential for optimum amplification. Qualitatively this proved the correct functioning of the system. Moreover, the system could be used as a frequency amplifier if the control condenser was coupled to a variable concentric Lechersystem. With a given wavelength in the control circuit up to the ninth harmonic could be extracted in the Lechersysten. For a quantitative investigation this wavelength was abandoned and the apparatus reconstructed for centimeter waves.

To avoid previous troubles due to disturbances by the earth's field and other unwanted fields, the system was built in an iron tube. The control circuit was not built in a different form as shown in fig.1.

It consists of a copper tube in which tooth-formed ribs were fixed diametrically opposite each other. Between their tips the electron beam received deflection if the electron beam velocity was adjusted so that its transit time between adjacent tips was equal to the period of the incoming oscillations. These had a wavelength of 24.5 cm. The HF was carried from a DVL transmitter via a tuned flexible lead and distortion detector with which the 1 kc modulation was produced and was monitored by a detector coupled to the final circuit. The operating (collecting) circuit consisted of a resonant chamber which could be tuned between 23 and 27 cm. The roof of this chamber carried a slit type aperture onto which the electron beam could be adjusted by electrical deflection. In addition a detector was coupled to this chamber to check HF presence in the collecting circuit.

At first the adjustment of the many parameters was found to be very difficult but the system operated in the expected manner and dependence of operation on the various parameters was checked. In time alterations will be made so that the optimum conditions can be easily set up. No definite statement can be made as to the power amplification without further measurements. The aim of further investigations is to determine this.

The operating voltage of the tube was about 1000. Theory showed that the velocity of the beam is very critical (to get the correct transit time between the deflecting plates), but in practice this was found surprisingly non-critical. No reason is known at the moment which can explain this.

By altering the width of the receiving slit in the resonant chamber, the amplifier can be given various characteristics equivalent to Class A, B or C working of a normal amplifier and the dependence of tube voltages etc., had a close analogy with normal valve operation. Dr.Muller claimed that similar systems on long wavelengths would give a lower noise factor than normal amplifiers.

As the investigators were not RF experts, a translation of a removed document covering this system of amplification is appended:-

"Report on the Development of a dm & cm Amplifier".

S/Ldr. G.C. Barker, TRE
Capt. J.K. Robson, RCDE

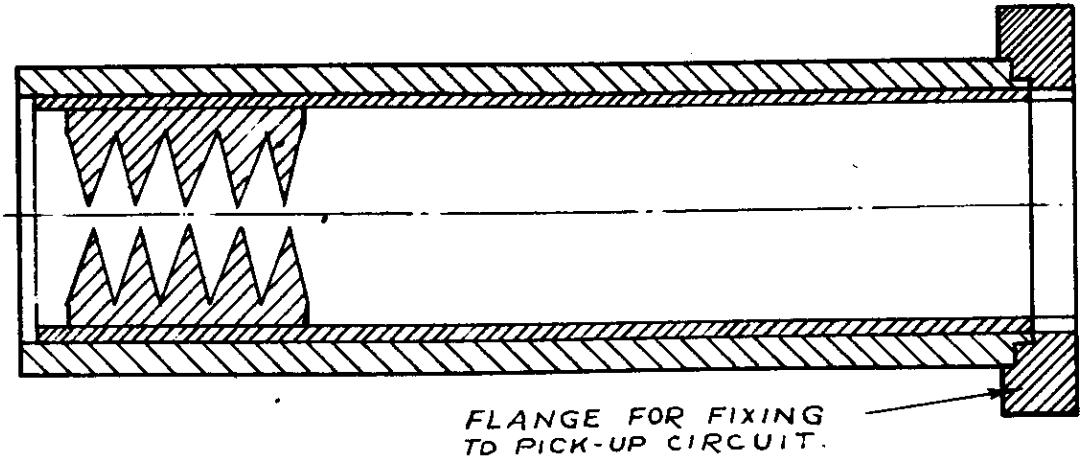
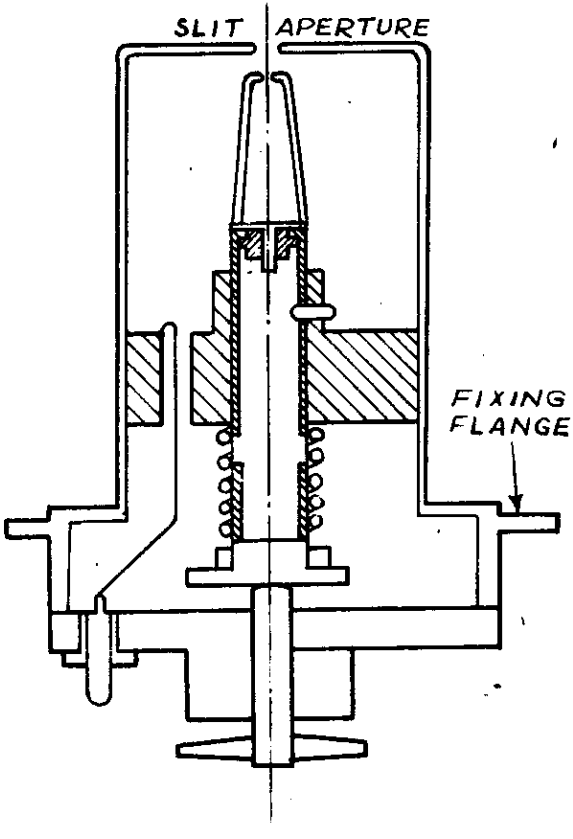
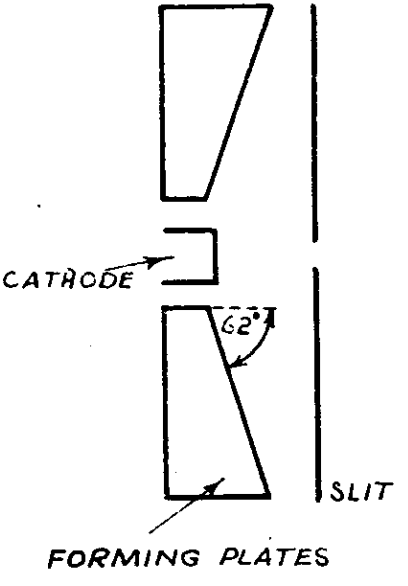


FIG. 1



TIMEABLE PICK UP CIRCUIT

FIG. 2.



CATHODE ASSEMBLY OF
BEAM DEFLECTION AMPLIFIER

FIG. 3.

REPORT XIV

Physikalerisches Institut der Universitat, Erlangen

Mr. C.W. Hansell and S/Ldr. Macfarlane. 13.6.45.

Prof. Dr. Rudolph Hilsch head of the Physics Institute was interviewed and gave the following information.

The staff under Prof. Hilsch consisted of 4 research and teaching assistants. The present organisation was set up in Jan. 1940, when Dr. Hilsch, student of Dr. Pohl of Gottingen, was called to the Chair of Physics at Erlangen. His predecessor, Dr. Gudden, had worked on semi-conductors for the Heeres Waffen Amt before departing for Prague. When Gudden left he took with him nearly all equipment (the property of Heeres Waffen Amt) in the labs.

When Dr. Hilsch became professor he was asked by the authorities to work on war problems but he asserted that he did so only to obtain equipment and materials for his own purposes. The only important war work he undertook was investigation of semi-conductors such as might be used in crystal detectors. His principle interest was in low temperature physics.

The institute was undamaged and his apparatus was in good working order. He took credit for saving not only his labs. but the whole city from destruction by the Americans. He acted as intermediary between the American and German Army Commanders, and surrendered the city after the German Commander had been shot in the back by fanatics who refused to surrender. He appeared to combine the necessary qualities of intelligence, forcefulness and imagination to play such a part.

Crystal-detector Investigations Report by R. Hilsch

Report on discussion about detector - problem held on 13th June, 1945 in the "Physikalisches Institut" Erlangen with Mr. Macfarlane and Mr. C.W. Hansell given by R. Hilsch.

The following brief report gives my opinion to certain problems concerning the detector. Though I have not worked directly about these things, they are in nearest connection to effects of semi-conductors, the region of my work. Moreover I know some details of investigations of other collegues. One of them, Dr. Konig (Gottingen, Physikalisches Institut) has done some work about thin layers of Germanium. He tried to make these layers by evaporation in high-vacuum. As far as he told me, no detector-effect occurred. The layers were amorphous as was shown by electronic diffraction. Dr. Konig has an electron - microscope at his disposal. With that he showed in a recent work, that a detector-effect with a metal-point only occurs, when the crystals are larger than 10^{-4}cm. He could get layers in crystalline state by depositing Ge-compounds in vapour state f.E. $GeCl_4$. Ge-crystal-layers of any desired shape shall grow according as the temperature of the porter-material (black-lead) is chosen. In connection to that, one student in my institute has investigated the behaviour of thin Ge-layers produced by sputtering the metal in high-vacuum.

A high voltage of 50 kilovolts (alternating-current, transformer) is between two pencils (5 mm diameter) of Ge. If the distance is no more than a few tenth parts of a mm a spark takes place and the substance sputters. A plate of metal can in this way be covered with Ge. The detector-effect is often very good. But it depends on the accident if the point touches a crystal of suitable size. Therefore we did not continue this method of producing detectors.

The practically used substances as Ge, Si are not proper for detecting the principles of the rectifying properties in general. The principle behaviour is more visible at substances as alkali-halides. I add two paper (1) u. (2) about steering of electronic currents. The light-electric problems are connected with these things. I tried a short time in 1940 to transfer the results to technical rectifiers 1940. But I had no success, since all dimensions of layers become too small. A summary of work done on alkali-halides given in the paper of Prof.Pohl (Gottingen, 1. Physikalisches Institut).

I am further interested in semi-conductors especially at very low temperatures. I hope to have results in the next time in connection with super-conductivity of substances.

I have to give reference to a recent paper of Justi:

Physik. Zs. 42, P., 349, 1941
and Physik. Zs. 44, P., 469, 1943

He succeeded in preparing substances as NbN with very high transition-point (25 degs K). This abnormal behaviour leads to many problems of semi-conductivity.

Zeitscarift fur Physik, Vol III, parts 5 and 6, 1938, p.399. paper by Hilsch and Pohl.

Die Naturwissenschaften 1939, Vol. 29, p.33.

R.W. Pohl - Elektron Conductivity and Photochemical Processes in Alkali-halide crystals.
Proc. of Phys. Soc. 49, 3, 1937.

Additional References

(1) Z. fur Physik, 1937, Vol. 108, P. 55.
(2) Nachrichten von der Gesellschaft der Wissenschaften zu Gottingen, vol. 3, Nr. 3.

References made by Dr.Hilsch to other research workers engaged on investigations into crystal-detectors.

1. Dr.Kluvius who was said to have discovered the rectifying effect of Germanium.

2. Dr.Welker of T.H. Munich was said to have made the first Germanium crystal detector in conjunction with F.F.O.

3. Dr.Schottky (now at Schloss Pretzfeld) was engaged on theoretical analysis of crystal detectors.
Dr.Schottky's theory was at variance with that of Drs.Pohl and Hilsch.

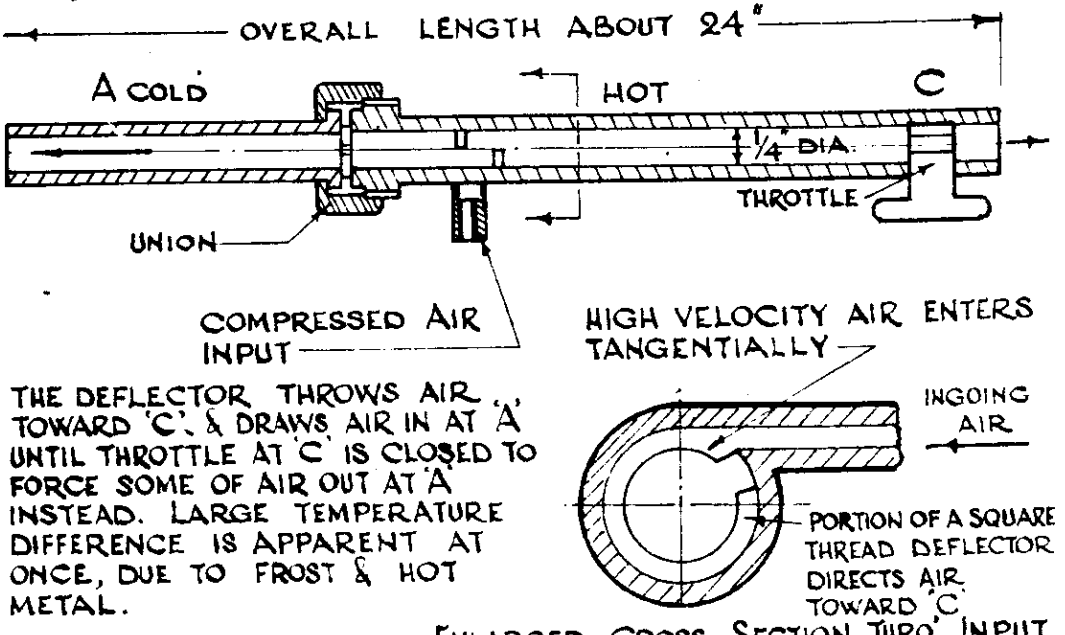
4. Dr.Stutzer of F.F.O. who performed high frequency tests on crystals.

5. Prof.Gaus also did work on crystal detectors but he had been interned in a German concentration camp.

Dr.Hilsch claimed to be well known to leading physicists in U.K. and had attended conferences in Bristol, Oxford and the Royal Institution in London.

Low Temperature Physics

Dr.Hilsch's outstanding interest was in low temperature physics at which he claimed to be a master. He showed to us apparatus which he asserted was superior to any to be found elsewhere in Germany. This superiority lay in its ability to cover a temperature range of about 773 degs K from the lowest temperature so far obtained. His apparatus was small in size and this he attributed to the use of several clever inventions. One such invention is illustrated in the attached sketch. A very convincing demonstration of this device was given.



ENLARGED CROSS SECTION THRO' INPUT

When cock at C is closed sufficiently to force current of air thru 1 iris (order of mm diameter) at B, portion of tube between B and C gets very hot and portion between B and A very cold.

Teaching Facilities

Dr.Hilsch had been approached by a U.S. General to give lectures on Physics to U.S. soldiers. He repeated for our benefit demonstrations previously given the General and his retinue to illustrate his method of teaching. These comprised:

1) Foucault pendulum experiment in which, by means of a long optical system, he increased the effect of the earth's rotation on the motion of the pendulum by 100: 1 so that the effect became visible a matter of seconds after the pendulum was released.

2) High Voltage electrostatic machine similar in principle to the High Voltage electrostatic generators used for nuclear research.

3) Wilson Cloud Chamber so arranged that the tracks of ionising particles can be projected optically onto a large screen for demonstration of radio activity and cosmic rays.

4) Optical demonstration of electromagnetic waves using tuned pick-up loop with lamp.

Superconductivity

Dr.Hilsch stated that he had obtained temperatures below 1 deg.A and had investigated the transition-point at which resistivity of materials vanishes. Among other things he had sought for substances with relatively high transition temperature.

In the course of his researches he discovered that CuS, although a good insulator at normal temperatures, becomes superconducting at 1.7 degs. A.

Although it was not his own work, he mentioned the discovery that NbN (Niobium Nitrite) had transition point at 25 degs K, which is far above the normal range of transition points.

Sidelight on Initial Attitude of Nazi Government to Scientists.

Interrogation of many German scientists indicates that the Nazi Government initially failed to appreciate the importance of physicists and their work. It was not until the Wehrmacht felt the weight of the achievements of the physicists of the Allied Nations that they recognised the essential part physicists play in modern warfare. As illustration of this Dr.Hilsch, although he was an outstanding physicist, was drafted into the Wehrmacht as a private early in the war and was used at the menial task of peeling potatoes. Upon representations of Prof.Pohl he was later released and eventually came to Erlangen.

REPORT XV.

INVESTIGATION REPORT

TARGET NUMBER Nil.

NAME OF TARGET Physics Institute (University of Vienna)

LOCATION Thumersbach - Villa Anna and Haus Brusatti

INVESTIGATORS

G.C. Barker	S/Ldr.	TRE	CAFT Gr I
J.M. Robson	Cpt.	ARDE	" " "
W. Abson	F/Lt.	TRE	" " "

DATE OF VISIT 21st June 1945

RESUME OF INTELLIGENCE

The Physics Institute had been largely engaged on academic nuclear research and quite recently had been evacuated to the Villa Anna and Villa Brusatti, Thumersback.

The nuclear aspects had already been investigated by Prof. Smythe of Princeton University (ALSOS) and Prof. Dr. Stetter the director of the Institute was asked to forward a copy of a report being prepared for Prof. Smythe to CAFT Group I through Capt. Brown of G-2, Keyway, Zell am See

In addition to the nuclear research the following persons were engaged on high frequency research:

Prof. Dr. Stetter
Dr. Weininger
Dr. Herzog
Dr. Beck

Most of the work was directed to the problem of radar camouflage. The use of multi layers of graded characteristics was under investigation for OKM. Some theoretical calculations had been made for plane waves falling on plane surfaces and appropriate measuring equipment was under development but no practical results had been obtained. Four reports had been submitted to OKM on the subject but all copies had been destroyed. In connection with this work a more academic investigation of the causes of the drop in permeability of ferro-magnetic materials with increasing radio frequency was being made. As yet however no results had been obtained. The aim was the development of materials of high permeability but no electrical conductivity such as mixtures of ferric oxide and magnesium oxide. In addition experiments were intended on the effect of viscous substances on the wavelength (wavelength at which S.I.C. falls to half its zero frequency value)

The measuring equipment had been completed but no results had been obtained.

CIOS CONSOLIDATED ADVANCE FIELD TEAM REPORT

TARGET NO: 1/113

DATE OF INVESTIGATION: 6th June 1945

UNIVERSITY OF VIENNA

TYPE OF TARGET: Physical institute laboratory for cm waves, and theoretical and nuclear physics.

LOCATION: Thumersbach, Lat N 47° 16' Long. E 12° 50' (Villa Anna and Villa Bursatti).

PHYSICAL CONDITION OF TARGET: Documents previously evacuated, equipment intact, guarded.

INVESTIGATORS: Mr. H.B. Marvin, Civ., USSTAF, CIOS
L.B. Mullet, F/Lt., RAF, CIOS
Mr. D.H. Hamsher, Civ., US Sig.Corps, CIOS

RESUME:

Prof.Stetter is in charge of the physical institute. Seh ?

a) Dr.Beck was not available and living at Zeitskammergut. Other workers in the cm wave group were Dr.Weiniger, Fraulain Watzner, Dr.Bieberschik, Frau Wiediger and Dr.Vellat (living at Kitzbuhlen). No work has been done except setting up a part of their equipment since they dispersed. They planned to study anomalous dispersion in water at 1.8 cm and longer wavelength. The plan includes dispersion measurements with water to which various organic liquids for increasing the viscosity had been added for the purpose of shifting the anomalous dispersion point to longer wavelengths. Work was requested by Prof.Ebert, of Physikelishe Chemische Inst., of Univ. of Wien. Also wanted to investigate the fundamental properties of magnetrsm by dF measurements on powdered iron.

b) Prof.Fues was in charge and had a librarian and part of the library, together with 3 students.

c) Dozent Jentschke, Dr.Prankel, Dr.Kaindl, Dr.Gundlach, Doz.Herzog, Dipl. Phy. Hilbert. Group worked recently on the absorption of neutrons by various elements, especially Be. Also work on the separation of energy levels in fission of uranium. The source of the neutrons was approximately 1½ gms of radium, owned by U.of Nieu, which is now in the neighbourhood of Salzburg and not available for their work. The counting equipment was elementary except for the mechanical counter which could count 300 counts per second made by Ludwig Gille, Prinzen Strasse 9, Berlin.

Prof. Stetter stated that he could work at Hammersbach if he could get the necessary equipment and materials, list of which has been given to Lt. Owen in Bell am See. He preferred either to keep the Institute at Hammersbach or move to Univ. of Innsbruck until the Russians evacuate Vienna.

List of Equipment Guarded - Both laboratories and contents.
List of Documents Guarded - Library for physical Institute.
List of Persons Guarded - Persons named in this report.
List of equipment to be removed - None
List of documents to be removed - None

Recommend institute be left intact until disposition can be determined.

Institute of Electrical Communications and Measuring Methods at Oberaudorf (evacuated from Munich)

S/Ldr. Devons, Lt.Cdr. Hipple, Cpt. Stewart and Lr. Bender investigated the Institute of Electrical Communications and Measuring Methods located not at Oberaudorf am Inn, Trafenburg, about 10 kms. north of Kufstein. The lab. was evacuated to this site from The Polytechnical Inst. of Munich about 18 months ago. The scientific personnel are as listed:

Director: Dr.Ing. Hans.Pilsty, Prof. of the Polytechnical Inst.
Asst. Director: Dipl. Ing. Paul Ederharter.
Staff: Dipl. Ing. Karl Appelaeier
Dipl. Ing. Ernst Gleicher
Dr.Ing. Walter Horner
Dipl. Ing. George Lirner
Dipl. Ing. Oskar Mattiat
Dipl. Ing. Ernst Rumpelt
Dipl. Ing. Hermann Rocha.

The total staff consisted of 35 people. Dr.Piloty is believed to be either at 49 Possenhafer Str, Starnberg or at Munich, but all the other personnel were there and were interrogated. - All reports of the work done there are available at the Inst. There has been no damage or looting and the whole place is virtually intact.

The Inst. was engaged with theoretical and experimental electrical and acoustical work in the frequency range from D.C. to 10 mc/s with the main emphasis from 50 cycles to 100 kc/s. The lab. is in good condition and is well equipped with the standard electrical apparatus, i.e about 8 oscillators, oscilloscopes, power supplies, frequency meters, but acoustic equipment is limited to a few commercial microphones and speakers. They were given isolated problems by other firms and seemed to be well isolated from combat apparatus design.

A general study of electrical wave filters was carried on in both the theoretical and experimental field by Prof.Piloty and Dr.Ing.Mattiat. This work involved narrow band pass and band rejection quartz filters, low and high pass filters, and theory of coils and condenser losses. Emphasis was placed on special applications for commercial communications, long range carrier telephony, television and radar. Much of this work including a volume compressor and expender for use in a high frequency multiple telephone system done by Dr.Horner, was commissioned by the Allgemeine Elektricitatsgesellschaft (AEG), Berlin.

The Heereswaffenamt, Berlin, commissioned the following series of problems:

Design of a proximity fuse circuit utilising sound radiated by an airplane. Done by Dr.Ederharter.

Attempt to reduce current drain of microphones used in military telephones. A magnetic field of over 20,000 gauss makes the solution of Dr.Horner impractical.

Construction of an electrical representation of a telephone cable. This was completed.

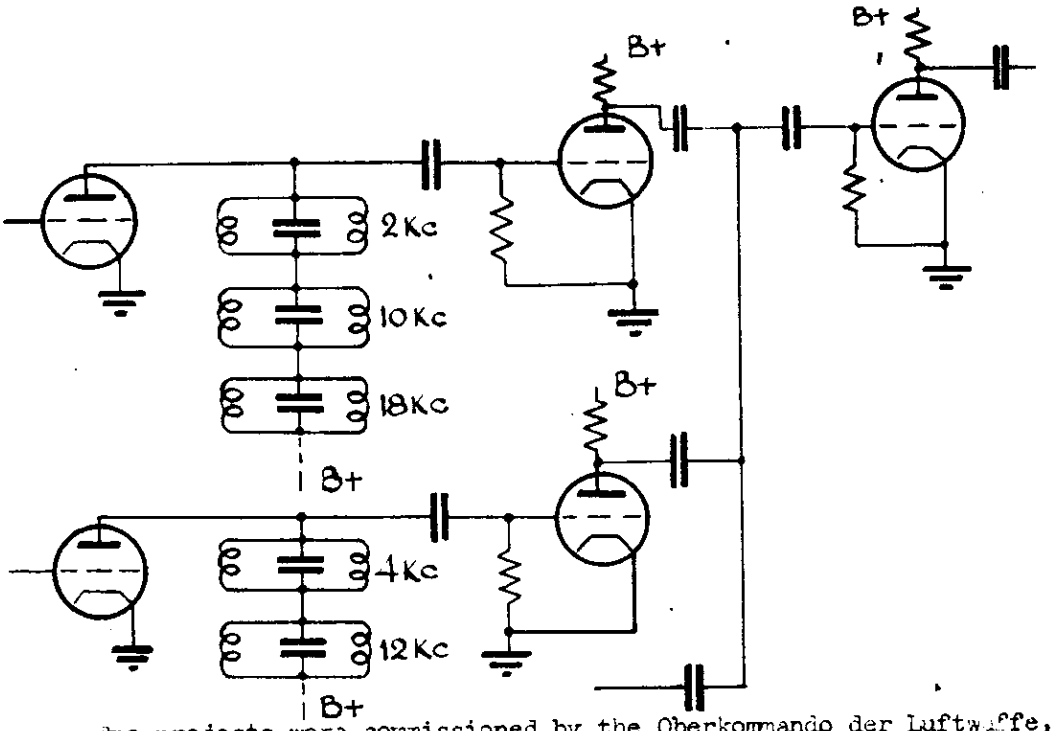
Design of a sensitive and reliable relay for remote steering using a bolometer, which is cooled by a steel reed set into oscillation by an audio frequency oscillation at the resonance frequency of the reed. The bolometer is in one arm of the bridge, a temperature-compensating bolometer in another arm, and the relay to be activated in the third arm. Hirner, Ehrmarter and Bleicky have not finished the work.

NVk

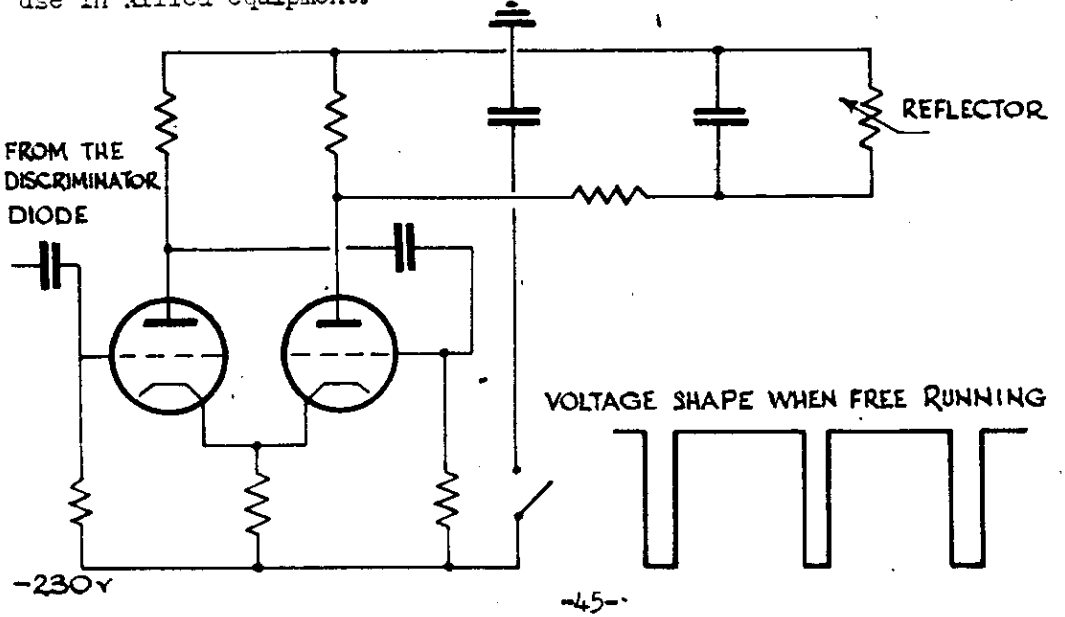
The Nachrichtenmittelversuchskommando der Kriegsmarine, Wolfenbuttel ordered an investigation of the possibilities of direction finding of underwater sound sources. The outputs of 2 microphones go to a narrow band audio amplifiers with constant amplitude output. The sum of the two signals go to one set of plates of a C.R.T. and the difference to the other set. The result on the tube is a straight line whose angle with the horizontal represents the phase difference of the sound received at the two microphones and therefore gives the direction of the sound source. Several spot frequencies can be used to increase sensitivity. Tests were carried out in the Starnberger See with two stationary microphones and an artificial source of sound. Dipl.Ing. Hecht and Dr.Horner directed this work.

RLM gem.

The Forschungsführung des Reichsministers der Luftfahrt und Oberbefehlshabers der Luftwaffe, Berlin und des Nachrichtenversuchs-amt, Berlin ordered work on a video amplifier for pulse transmission to improve the signal to noise ratio of radar sets. The Fourier components of a fixed frequency repetition rate of a square pulse consist only of the fundamental and harmonics of the repetition rate. Use of an amplifier which amplifies only these harmonics within a range of 4 to 300 kc/s should give a fair pulse slope and appreciably less noise. The essential part of the circuit is given here. The amplifier is approx. 3 .. 3 x 1 feet and the tuned circuits must possess high stability. The repetition rate of the radar set must be accurately controlled.



Two projects were commissioned by the Oberkommando der Luftwaffe, Berlin and the Atlas-Werke, Bremen; Zweigwerk, Munchen; Aussenstelle, Hechtsee and Kiefersfelden. One was the improvement of the a.f.c. in the American APG 15 radar. The 6AC7 video and the 2050 gas tube were replaced by a twin triode unsymmetrical multivibrator. When the set is approx. in tune, only a 30 mv pulse is sufficient to stop the multivibrator action. There is a filter to smooth out the a.c. pulses on the anode. If the set is not in tune, it is necessary to hold the switch down manually for a short time. Far superior techniques are already in use in Allied equipment.



The plan was to build a 10 megacycle i.f. to test this u.f.c., using 10 megacycles since that was the highest frequency their apparatus covered. The second radar tank was to prevent showing ground return in a night fighter radar, by suppressing the video gain. This was to be done on a time basis only, determined by the altitude of the plane.

Telefunken, Berlin authorised an investigation of filter circuits which would transform a square wave pulse into a pulse of arbitary shape. The Allgemeine Elektricitatsgesellschaft (AEG), Berlin requested an investigation of general problems of volume control in the radio freq. range.

A complete list of reports by this institute, all of which are available there, follows:

Various reprints from the magazine "Telegraph, Telephone, Radio, and Television Technic" from the field of filter theory.

Measurements on electrical amplifiers for the hard of hearing. A dissertation, March 1941.

Practical design of electric filters. Work is not finished.
1. Report up to April 1942
2. " " " Feb. 1943
3. " " " Nov. 1944

Theoretical experimental work on electric filters (low and high pass, band pass and band rejection) for special purposes. Work is not finished.
1. Report up to Sept. 1941
2. " " " Feb. 1942
3. " " " Sept. 1943
4. " " " Jan. 1944

Development of a circuit for a proximity fuse operated by the noise of the target airplane. Work finished.
1. Report up to June 1941
2. " " " Aug. 1942
3. " " " Sept. 1943

Analysis on microphone efficiency in order to reduce current required for a military telephone. Work finished.
1. Report up to Oct. 1940
2. " " " Dec. 1941.

Construction of the electrical equivalent of a telephone cable. Work finished.
1. Report up to Dec. 1937
2. " " " May 1938
3. " " " Dec. 1938
4. " " " July 1939
5. " " " Aug. 1939
6. " " " Aug. 1940

Development of a resonance relay for remote steering. A steel tongue, set in resonance by an audio freq. cools a bolometer set in one arm of a bridge. Work not finished.
1. Report up to Oct. 1943
2. " " " Aug. 1944

Experiments under water involving the sum and difference technique for sound direction finders. Work not finished.
1. Report up to Feb. 1945

Experiences on sound direction finding with visual indication.
Work not finished.
Aktennotiz up to June 1944

A many band filter for amplifying the harmonics of a pulse of definite repetition rate and width. Work not finished.
1. Report up to March 1945

Improvements of the a.f.c. in the American APS15. Work not finished.
Report up to April 1945.

General questions of sound Direction Finding. Work finished.
1. Report up to Dec. 1937
2. " " " May 1938
3. " " " Dec. 1938
4. " " " June 1938

Calculation of filters to transform a square wave pulse into an orbitrary form. Work finished.
1. Report up to Nov. 1942
2. " " " Feb. 1943
3. " " " Feb. 1943
4. " " " March 1943

To: Major N. Johnson-Ferguson
Subject: CIOS Preliminary Report
Target: Physical Chemistry Laboratories, Leipzig University.
Purpose of Visit: To interrogate Prof. Bonhoffer on his wartime research work.

Narrative: Prof. Bonhoffer was contacted at his home (Am Wasserwerk 7, Leipzig) and gave the following account of his activities during the war. Both investigators were convinced of his sincerity as an Anti-Nazi.

In November 1939, he received a letter from Prof. Schuhmann of Berlin University who was leader of the Heereswaffenamt informing him, that, unless his activities were confined to problems connected with the war effort, he would soon lose all his research workers and assistants to the army and to other research organisations. Prof. Schuhmann gave him the choice of several problems all of which were turned down as being outside his line of work, but during the course of the meetings with Schuhmann, Prof. Bonhoffer became slightly acquainted with the Uranium Problem group. This resulted in him joining Heisenberg, Clausius, Bothe, Hahn, Klopfermann, etc. in work on this problem, his particular corner being research into the problem of producing the enormous quantities of Heavy Water required. He considered the problem almost impossible of immediate solution but worked on catalysts for the missing process whereby Deuterium is mixed with pure water to enrich its content. He tried Nickel and Platinum palladium catalysts in various ways, but with no real success. He was connected with this work from 1940 right up to the end of the war.

He had been personally interested at the start of the war in the propagation of nerve impulses and the assimilation of Deuterium in growing plants and later applied to the Forschungsrat for permission to continue this work. He was allowed 100,000 RM to work on the allied problem of corrosion which he claims to have used as a cover for further work on nerve propagation. He claims to have developed his ideas further than Hill of Cambridge and to have formed a reasonable picture of the processes involved in Passivity.

In December 1943, his institute in Leipzig was completely destroyed during an air raid after which he was contacted by Osrams and offered a very attractive post in their Research Organisation. It would appear that Mey who at the time was in charge of Osrams research was primarily interested in valves and the reason for Osrams approach was to broaden their research work to include work on Phosphorescence and High Pressure Mercury Arc lamps with a view to post war trade. He eventually accepted the post on the basis that half of his time should be spent with Osrams in Berlin and half at Leipzig, i.e., in his own words, he did nothing for either! Most of his time at Osrams had been spent in finding out the details of their existing research, especially in connection with the use of Titanium as a replacement for Tungsten filaments. He claimed that a very serious tungsten shortage was facing Germany and that Osrams was

practically the only firm engaged in making filaments; he further expressed great astonishment that the Osram Tungsten factory in Berlin had not been bombed - it was untouched up to March 1945.

Toward the end of the war, he had just started work on Phosphorescence at Osrams but had not got far enough to find out anything of interest or importance.

He had been quite intimately associated with the German Underground Movement - two of his brothers had been sentenced to death and a third had been placed in a Concentration Camp. widerstandsbewegung

Target:- Goettingen University - Physics Laboratories.

Investigators:- S/Ldr. G.C. Barker, T.R.E.
Capt. T.M. Robson, R.R.D.E.

Date of visit:- May 31st.

Purpose of Visit.

Investigation of high resolution zinc oxide fluorescent screens previously reported by C.A.F.T. assessors.

General Results of Visit.

Details were obtained of the method of preparation and of the physical properties of zinc oxide screens prepared by an evaporation process. These screens are capable of high resolution, the grain size being of the order of 0.5 microns and their sensitivity being the same as zinc oxide screens prepared by settling from an aqueous suspension.

Detailed Results.

The work on these screens had been carried out by Prof. Mollwo in Prof. Pohl's laboratory and all the information on this subject was obtained by interrogation of these two persons.

The work had been carried out as a largely academic project during the war with some thought to the possibility of using such screens in Bildwandler tubes on in projection C.R.T.'s.

The primary aim had been to produce a screen consisting of very small fluorescent particles very tightly packed together in order to obtain a practically continuous surface of fluorescent material. After some initial experiments on zinc sulphide screens which had not been successful zinc oxide screens with the desired continuity of structure had been prepared by the following process. Zinc powder is evaporated in an ordinary oxidising gas flame using a burner of special design. The fluorescent screen is formed by placing a glass plate at a suitable position in the flame. Usually the glass plate was placed in a portion of the flame with a temperature of 200°C. The zinc oxide formed by oxidation of the zinc vapour condenses on the glass plate to form in time a tough, strongly adherent film whose properties can be controlled by adjustment of the position of the glass plate with respect to the flame and also by adjustment of the ratio of oxygen to gas in the oxidising flame. As prepared for use in CRT's the films contain a certain quantity of free metallic zinc and are yellow in colour. The grain size is of the order of 0.5 microns and the tightness of packing of the screen particles is such that the density of the screen material is approximately twice - that of screens produced by settling zinc oxide from an aqueous

suspension and is also practically $\frac{2}{3}$ of the density of zinc oxide single crystals.

The efficiency of these screens is almost the same as that of screens produced by settling zinc oxide from aqueous suspension but is of course only about 20% of that of zinc sulphide screens. The screens are however more resistant to electron burning than settled screens by a factor of 2 or 3. Measurements have been made of the spectral characteristics of these screens and also of their secondary emission characteristics and details of the results of these measurements together with details of the method of preparation of the screens are given in a report which was removed. The conductivity of the screens is high as compared with normal zinc oxide screens owing to the closely packed structure and also to the presence of free metallic zinc. This fact combined with the better resistance to electron burning is of importance when such screens are used in Bildwandler tubes or in projection CRT's. The resolution given by the screens if of the order of I micron and therefore the imperfections of the electron optical system would be the binding factor to resolution of any tube using these screens.

No practical use had been made of these screens in Bildwandler tubes or in projection CRT's - the work not being sufficiently far advanced.

Dr. Helweg, working in the same building, had worked for some years on the Anti-radar for N.V.K. His work in recent years had however been confined to laboratory measurements of absorption, dielectric constants etc. and since it was believed by the investigators that the German Anti-radar work had already been completely covered no detailed investigation was made.

Prof. Zahn of the Applied Physics Laboratory was also interrogated but nothing of interest to CAFT teams was discovered, his working during the war being confined to studies of the recrystallisation of amorphous metallic layers.

TARGET EVALUATION REPORT

1. Target Number or Designation

2. Name of Target... Institut fur angewandte Mechanik, Goettingen.

3. Type of Target... Institute for Applied Mechanics.

4. Location Town... Goettingen
Burgerstr.42

5. Date of Investigation... June 22nd, 1945.

6. Physical condition of target... Intact.

7. Investigators:

NAME	RANK	ORGANIZATION	AGENCY REPRESENTED
SADLER, D.H.	Cmdr.RNVR	Admiralty	CIOS
HOYLE, F.	Lt/Cmdr.RNVR	"	"

8. Resume of Intelligence gained by Investigation:

The Institut fuer angewandte Mechanik der Universitat, Goettingen was visited with a view to obtaining information concerning a pendulum clock built by Prof. Schuler. It is claimed that this clock has an accuracy which exceeds all previous pendulum clocks and which is comparable with that of quartz controlled clocks. An electrical system comprising a photo-electric cell and an electro-magnet is used to give an impulse to the pendulum at each oscillation. The amplitude is maintained constant within one or two percent by this method. It was stated that the probable error was about a twothousandth of a second per day. 2.10^{-3} s P/d

The investigators were shown over the Institute by Dr. K. Stellmecher. The gadgets now on show were clearly intended for the training of students, but the very great mechanical ingenuity of these devices, together with the workshop facilities available at the Institute, would suggest that other activities may well have been carried on there.

Physics Institute, Goettingen.

CIOS Target 9/89.

Date of visit: 20.5.45.

Investigator: Mr. D.H. Hamsher.

Report of D.H. Hamsher, CIOS on Target 9/89

Group Leader - Major J.W. Harding (English)

Visits were made to Physics Institutes 1 and 2, the first headed by Prof. Pohl and the second by Prof. Koffermann, and to the Applied Electrical Institute by Prof. Zohn. Reports of recent work in many approaches to studies of thin films were obtained and the more important work was discussed with the research personnel involved. Secret material found in the area previously had been evacuated so a complete picture could not be made. Some lines of work may require further study by Allied scientists to fully determine the applicability of this work to military equipment or, if reports are obtained from other research institutions carrying on the related work immediately applications may be made if found to be better than ours.

TARGET EVALUATION REPORT

1. Target Number or Designation

2. Name of Target... Universitaets-Sternwarte, Goettingen.

3. Type of Target... Astronomical Observatory.

4. Location Town... Goettingen.

5. Date of Investigation... June 22nd, 1945.

6. Physical condition of target... Intact.

7. Investigators:

NAME	RANK	ORGANIZATION	AGENCY REPRESENTED
SADLER, D.H.	Cmdr.RNVR	Admiralty	CIOS
HOYLE, F.	Lt/Cmdr.RNVR	"	"

8. Resume of Intelligence gained by Investigation:

The University Observatory, which is Gauss' old home and an "ancient monument", appears to have played no direct part in the war. The Director (Dr. ten Bruggencate), appointed in 1941, was most co-operative and appeared genuinely desirous of giving all the information he could. He supplied the present whereabouts of the chief German astronomers, but fought rather shy of direct questions regarding those suspected of extreme (either way) political views. Generally it is clear that German astronomers were not put on to war jobs to the same extent as, for instance, British astronomers; this view is upheld, in ten Bruggencate's case, by the large number of astronomical papers he was able to write during the war.

2. The Astronomisches Rechen-Institut (known as the Copernicus Institut) of Berlin-Dahlem has been evacuated to SERMUTH, nr. Grimma in Saxony.

3. Dr. ten Bruggencate confirms that the German time service originates from Hamburg (Deutsche Seewarte) and is based on pendulum clocks (i.e. not on quartz crystal oscillators). ??

4. Other information appears to have no relevance outside purely astronomical circles.

CIOS CONSOLIDATED ADVANCE FIELD TEAM
INVESTIGATION REPORT

TO: CIOS Secretariat.

1. Target No.

2.3. Laboratory of the Technical High School, Berlin, evacuated to Bad Liebenstein. Person interrogated: Dipl.Ing. Erwin Weise, formerly of Osram, now attached to this laboratory.

4. Interview only. Ovens and vacuum equipment for experimental work are in workable condition.

5. (1) Semi-conducting materials such as titanium-titanium dioxide resistors.
(11) Investigation of very thin films of titanium dioxide (TiO_2)
(111) Practical applications involving the use of these thin films:-
a. Pyrometers.
b. Gas pressure and flow devices.
c. Rapid acting simulated pendulum.
(1V) Electrically controlled friction devices for control and amplification of mechanical forces.

6. Laboratory subject to guard regulations of 8th Corps Area. A book was just being written on the subject of semi-conductors by Mr. Weise, and it is desirable to obtain a copy when available.

7. Priority.

8. Mr. Weise spoke disparagingly of Dr. Pearson's published works on semi-conductors (Bell Laboratories). He was scheduled to lecture in America on this subject prior to the war at the request of Western Electrical Instrument Co., Irvington, NY. Claims to be a friend of Henry Behring of this company.

9. 5th June 1945.

10. Investigators: Mr. C.W. Hansell
Lt. Col. J.J. Slattery
Maj. J.M. Sanabria
Pfc. F. Koppl

11. Documents removed: "Uber ein Messgerät für hohe und niedrige Gasdrucke mit Halbleiterwiderstanden" by Erwin Weise. Zeitschr.f. techn. Physik, No.4 1943, pages 66 to 69. No reports were available at the time but Mr. Weise stated that a manuscript of his should be produced within thirty days, and it is suggested that this matter be further investigated.

SEMI-CONDUCTING MATERIALS.

For present purposes semi-conducting materials may be defined as that type of material, the resistance of which does not follow the same general laws as those of metallic resistors. It is also characteristic of them that the heat conductivity is not proportional to the electrical conductivity. These properties of semi-conductors may be explained by assuming that the numbers of free electrons is variable. Some solid semi-conducting materials exhibit ionisation and conduction by motions of both electrons and ions in a manner similar to conduction in gases. These are not generally useful for direct current because of polarising effects caused by the electrolytic part of the conduction. Mr. Weise has concerned himself with another class of semi-conductors in which conduction is not accompanied by ionic motions and polarising effects. His work was concentrated upon the development of titanium-dioxide semi-conductor combinations.

URDOX RESISTORS.

Thermally sensitive resistors have been produced in considerable quantities by Siemens in Berlin, under the trade name of URDOX. These Urdox resistors have a large change of resistance with change of temperature. The value of the resistance follows a logarithmic law with respect to the inverse of absolute temperature within the prescribed operating range. This range must always be something less than 600 degs. C and nominally is set as 300 degs. C.

In the manufacture of Urdox resistors, finely divided titanium dioxide and magnesium oxide are mixed with water and extruded like any ceramic, at an extrusion pressure of from 100 to 200 atmospheres. The extruded rod is cut into nibs. These are coated with molybdenum powder on the ends for contact purposes. The material is then baked at a temperature of about 1,000 degs. C to form a ceramic insulator of extremely high resistance. The insulator is converted into a semi-conductor by subjecting it to a second baking at a carefully controlled temperature in the range of 1,200 to 1,400 degs. C, in an atmosphere of hydrogen or containing hydrogen. The hydrogen reduces the oxygen content of the material, leaving an excess of titanium which causes the material to become semi-conducting. It changes color from white to black or dark grey in this process.

The value of the resistivity of the finished product is dependent first of all upon the percentage of magnesium oxide present, and next upon the heating temperature and time, which must be carefully controlled. It also depends upon the atmosphere in which the second heating is done. Mention was made of other gases which may be present, including nitrogen, argon and waterdamp.

In the process of formation of the material the dielectric constant changes, and this change may be used to control the forming process. In actual production close control of conditions, arrived at empirically, is depended upon to provide a uniform product.

The molybdenum coatings at the ends of the resistors are copper-plated for better contact as a final step in manufacture.

It is understood that the resistors have no sources of electrical noise within them, other than the minimum thermal-agitation noise. However, mention was made of some contact noise phenomenon. Noise - Ramshaw.

Uses for the Urdox resistors comprise the following:-

1. accurate temperature measurement and control,
2. voltage regulation and control,
3. volume controls without noisy sliding contacts,
4. automatic motor and filament starters.

THIN FILM RESISTORS

Considerable work has been done on the development and applications for very thin films and threads of titanium dioxide semi-conducting materials. These have very small heat storage capacity and consequently can be made to exhibit large changes of resistance in response to very small addition or subtraction of energy.

The films have been formed by mixing TiO_2 with a binder such as starch or colloidion, which is formed into thin paper like sheets. These sheets may be bent, cut and mounted as desired. They are then subjected to heat processes similar to those used in making resistors, The binder is removed by the first heating. Films of 30 microns thickness have been made. These are rather fragile after the first firing but improve during the second firing.

The thin films are potentially very useful for measuring incident radiant energy, as in pyrometers and infra red detectors, not only due to their small heat storage capacity but also due to their blackness or high absorption of all radiation frequencies. They may also be used with fixed input energy to measure gas pressures over a very large range of values extending down into the range of pressures provided in X-ray tubes.+)

For any given pressure range, the sensitivity of indication can be made to approach the infinite because of the regenerative or dynamic negative resistance effect which can be provided by operating the material with an applied potential which is adjusted high enough. If input energy can lower the resistance to make the input energy

increase itself, complete instability of resistance is possible and actual oscillations of current have been obtained, when suitable input power circuits were used. In practice the condition of instability should not be approached too closely.

Proposed applications for thin films and threads comprise:-

1. automatic control of vacuum pumps,
2. simple and accurate recording of pressure versus time,
3. measurement of direction and velocity of flow of gases,
4. rapid acting simulated pendulums,
5. pyrometers,
6. accurate measurement of very small angles, ++)(5 minutes per division of a 100 division instrument has been demonstrated.)
7. Micrometer, sensitivity of 0.1 mm per division has been obtained.

In the foregoing the rapid acting simulated pendulum may be of interest; in one form it consists simply of an electrically heated horizontal wire above which are two parallel spaced titanium dioxide thermally sensitive resistance threads. All are enclosed in a glass bulb with gas at a suitable low pressure. Gas from the heated wire rises against the force of gravity past the thermally sensitive resistances, determining their relative temperature and therefore their relative resistances. Any tilting of the plane of the two elements from the vertical changes the relative temperatures of the sensitive elements and thereby causes differential resistance changes which may be used to operate an indicating or control system. The device exhibits all the response properties of a pendulum free of swing in one plane, but can respond much faster than a mechanical pendulum.

Such devices have been suggested for use in airplanes, flying bombs, and various stabilising devices. The Luftwaffe was interested in this development and ordered work to be done on it.

ELECTRICALLY CONTROLLED CLUTCHES.

Many years ago it was demonstrated that the friction between a semi-conducting material and a metal shoe sliding over it could be varied over a large range of values by passing a variable electrical current through the surface between them. Attempts were made to use the phenomenon to provide electrically controlled

+) see report "Uber ein Messgerat fur hohe und niedrige gasdrucke mit Halbleiterwiderstanden" by Erwin Weise. - Zeitschrift fur technische Physik, No.4, 1943.

++) see German patent P81 945 IX b/42c "Elektrischer Neigungsmesser" Berlin, 8th May 1942.

clutches and the clutches did find some use in telegraph signal recorders. The development was abandoned because of the poor quality of semi-conductors then available.

With the development of the new titanium dioxide semi-conductors this old abandoned development has been revived with much more promising results, because of the relative perfection, uniformity and hardness of the new materials. It has been suggested by Mr. Weise and others that electrically controlled friction clutches may very well assume considerable importance in the future.

In general the clutches provide control of mechanical power by electrical power in a manner to give very great amplification and rapid response. For many applications they might replace the Amplidyne or Metadyne control devices which are now in use on a large scale in military equipment and in industry.

THERMAL ELECTROMOTIVE FORCE OF TiO_2 SEMI-CONDUCTORS

Mr. Weise said that titanium dioxide types of semi-conductors had been found to provide thermal electromotive forces about ten times greater than that of metals and that this might lead to important applications.

ELECTRONIC AMPLIFIERS WITHOUT VACUUM.

According to Mr. Weise he had some ideas and had demonstrated the possibility of using thin films or control electrodes in semi-conducting materials to provide control of current flow similar to the control of current flow in high vacuum tubes. This work had not approached a stage where practical applications might be made.

APPENDIX I.

Literature on the Subject of Semi-Conductors published by Erwin Weise.

1. Patents:-

DRP 607 444 Carrier with two records of oscillations in one trace.
618 982 Control resistor to diminish the starting time of cathode.
632 820 Network for the quick starting of cathodes in discharge-tubes.
641 680 Pipe-shaped high frequency furnace.
696 463 Manufacture of very thin semi-conductors.
697 174 Resistors of semi-conducting materials.
701 478 Electrical measurement of low gas and steam pressures.
716 052 Equipment for fitting very thin semi-conductors.
721 677 Stabiliser for DC and AC voltages.
730 251 Equipment for fitting very thin semi-conductors.
743 780 Measurements of the velocity of gases, slight changes in air pressure, and altitudes of aircraft.
743 575 Network to raise the slope of the characteristics of electron tubes.
(secret) Use of resistance controller as an amplifier and generator of slow electrical oscillations.
(secret) Instrument for measuring the inclination of ships, incorporating semi-conductors of little inertia.

2. Books and Papers:-

1. "Technical uses of Semi-conductors" publ. by J.A. Barth. +)
2. "Science of Semi-conductors" together with another author, publ. by J.A. Barth. +)
3. "Electrical conductivity in solids" by Prof.Dr.Justi, chapter on "Semi-conduction" together with another author. publ. by Springer. +)
4. "Physical Pocket Book" by Dr. Ebert, chapter on "Semi-Conductors and Electrolytic Conduction in Solids" publ. by Springer. +)
5. "Modern Methods of measuring Vacuum between 760 and 10 Torr, +)
6. "The Temperature-Resistance function of semi-conductors" +)
7. "An application of Semi-conductors for measuring small slopes" +)
8. "Measuring the velocity of gases with Semi-conductors" +)
9. "Manometer for high and low Gas-pressures, using Semi-conductors" Zeitschr.f.techn.Physik, No.4. 1943, p 66.
10. "Physical properties and Applications of Semi-conductors" Zeitschr.f.techn.Physik, No.59, 1938, p 1085.
11. "Semi-conducting Materials and Resistors" Techn.wiss. Abh. Osram. No.5, 1938.

12. "Examples of Bridge-Networks incorporating Semi-conductors" Zeitschr.f.techn.Physik, No.18, 1937, p 467.
13. "Accuracy and Timefactors in Mathematical Calculations of Equalisation. Zeitschr.f.techn.Physik, No.20, 1939, p 59.

APPENDIX II.

A World-Review of the Manufacture of Semi-Conductors.

Germany:-

OSRAM. In 1932 the Urdox Resistors came on the market and over ten million of these were sold previous to 1939. There were more than 90 different types covered by about 40 patents.

SIEMENS. In 1936 manufacture of about 20 types was begun on a small scale in order to supply their own requirements. Many difficulties were experienced on account of unsuitable materials. This limited their practical applications, e.g. for small loads and AC use only. No more than 50,000 were sold previous to 1939.

Holland:-

In 1936 the so called "Starto-Tubes" were mentioned in the "Philips Technische Rundschau". These however never came into the market in any great number, the materials being unsuitable.

U.S.A.:-

In 1940 the so called "Thermistors" were mentioned in the "Bell Lab. Record" by the Western Electric Corp. New York, by Pearson. The materials were completely unsuitable but no details were known in Germany.

England:-

There is no manufacture in this country. In 1942 an article appeared in the "Journal of Scientific Instruments" on the American Thermistors.

Russia:-

Only scientific publications by Davidoff, Frenkel and others are known.

R E S U M E

EXTRACT: Zeitschrift fur technische Physik, No.4, 1943, pp 66-69.

Report on a Manometer for high and low Gas-pressures, using semi-conducting Resistances.

(Uber ein Messgerat fur hohe und niedrige Gasdrucke mit Halbleiter-widerstanden.)

by Erwin Weisse, Berlin.(Osram).

The report describes a simple instrument for the measurement of gas and vapour pressures, which has the advantages of giving a direct indication, a predetermined sensitivity for almost any range within wide limits, and large control currents. With a suitably large Magnesium-Titanium-Spinell film, control currents up to 100 mA may be obtained which can be used directly for controlling or recording purposes. The thickness of the resistance element is about 20 microns with a surface of about 10 sq. cm. The film is attached to two tungsten coils - similar to those in incandescent lamps - by means of a conducting adhesive. During operation the ambient temperature should be constant and to obtain this, a jacket for water cooling is provided on the instrument. Fig.1 in the report shows in detail the mechanical construction of the instrument.

Measurement is obtained by measuring the current through the film by an ordinary milliameter in series with a normal resistance, and connected to a constant voltage supply. Fig.2 in the report shows the voltage versus current characteristics of an element at different gas pressures. Decreasing the value of the series resistance will result in a decrease in the range of the instrument but the sensitivity increases. Thus any required range and sensitivity may be obtained by appropriate selection of the series resistance and applied voltage.

Fig.3 in the report shows calibration curves of these manometers, which follow the general law appropriate to heat conduction manometers.

The type of gas as well as the position of the film in the gas will effect the calibration since the cooling of the film is thus effected. These effects are described in greater detail and figs. 4 & 5 show curves appertaining to these phenomena.

Applications are outlined and illustrated, in particular pressure versus time recording over a large range of pressures, and automatic control of vacuum pumps by applying the control current directly to a relay. So far the equipment has only been used in the laboratory, a standard instrument not yet being developed.

Interview with Dr. Schottky

Interviewers: S/Ldr. G.G. Macfarlane and C.W. Hansell.

While we were at Pretzfeld on June 14 1945, to investigate the Siemens establishment there, we found that Dr. Schottky of the University of Berlin, and Dr. Emde of the Technische Hochschule at Stuttgart were in the town. In the evening we were able to contact Dr. Schottky and have a short interview with him. He is a theoretical physicist who is well known to radio engineers because of his analysis of the effect of the discrete charges carried by electrons upon noise generated in vacuum tubes. This source of noise he called the "schiöt" or shot effect.

Dr. Schottky said that, in recent years, he had been making theoretical analysis of the phenomena taking place in fluorescent materials during the production of light, and the phenomena in semi-conductors with particular emphasis on rectifiers and crystal detectors.

There was insufficient time available to go into this work in detail but Dr. Schottky has been preparing some papers for publication and has promised to forward copies to London for addition to the C.I.O.S. collection of documents, when they become available.

He pictured the rise and decay phenomena in fluorescent materials as being caused by the displacement of electrons, a waiting period during which the electrons are inactive, perhaps moving about due to thermal forces, and then an active light emitting period as the electron finds a new hole for itself in an ionised molecule. He has made quantitative analyses for certain cases to support his theory.

Dr. Schottky has also worked out a theory of the phenomena in crystal detectors and in semi-conductors generally. His theory apparently is not the same as that of Dr. Rudolf Hilsch of the Physikalisches Institut Der Univeritate Erlangen so that comparison of the two theories, when the papers describing them are received, should be of interest.

In spite of his long study and analysis of the phenomena in fluorescent materials and semi-conductors Dr. Schottky said he had nothing he could suggest which would enable us to obtain better results in practice.

TARGET EVALUATION REPORT

1. Target Number or Designation... Target of Opportunity.

2. Name of Target... Physical Institute of Berlin, dispersal.

3. Type of Target...

4. Location Town... Reifenstein Map Coordinate .... (if available) near Leinfeld

5. Date of Investigation... 6 June 1945.

6. Physical condition of target... Intact except for minor looting.

7. Investigators:

NAME	RANK	ORGANIZATION	AGENCY REPRESENTED
N.Johnson-Ferguson	Major	R-Signals	T-Branch G-2, 12th AGp

8. Resume of Intelligence gained by Investigation:

The target consists of a large room full of optical instruments (microscopes, projectors, comperators, etc.), a few electrical measuring instruments, chemical balances and the like, such as would form the normal equipment of an instructional laboratory.

The research equipment consisted of the usual miscellany of optical and electrical gear, but notably some high voltage condensers, and some photographic printing equipment.

Dr. SCHALL was interviewed, and stated that he and his family had been evacuated from Berlin in March; that he had been working for Prof. SCHUMANN on a method of taking photographs at very high speed, on behalf of the Wehrmacht, to show the action of explosives. The method employed the usual one of a condenser charged to 100,000 volts and discharging through a cold cathode discharge tube. On any one experiment he could obtain three exposures of duration of one microsecond, at intervals of 100 microsecond. He stated that he had no records or specimens of his work, as they had all been lost in the move.

A student engineer named WILSTORF was stated to have been working on routine crystallography, for his degree. He was not available for interrogation.

It was stated by SCHALL that some students, believed still in Berlin, had been working on nuclear physics.

CIOS - CAFT GROUP 1 ASSESSMENT REPORT

1. TARGET NO: Nil

2. FULL TITLE OF TARGET: Institut fur Elektrische Messkunde und Hochspannung Technik. Technische Hochschule.

3. LOCATION: BRAUNSCHWEIG

REMARKS: Prof.Dr.Ing Ervin Marx, the head of the department was away in Stuttgart and not expected back for one week. The following information was obtained by interrogation of his assistants, Dr. Fraube and Herr Fritzsche.

The only work carried out by Prof. Marx which was directly connected with the war was the development of spark jammers for wavelength below 3 metres. This work was initiated by NVK as a result of the serious valve shortage in Germany. Enclosed spark gaps were employed, the electrodes being made of aluminium or magnesium with gaps of the order of 0.1 mm. in an atmosphere of hydrogen at a pressure of 20-30 atmospheres. Recurrence frequencies of up to 20 megacycles for the discharge had been obtained. Some work had been done in the 7-9 ans band but they had no idea of the power output or efficiency. No theoretical calculations had been made of the efficiency of such jammers. The work was still in progress at the end of the war and no operational use had been made of such jammers in any frequency band. All reports had been destroyed at the end of the war.

Prof. Marx has also for a long time been working on a system for the distribution of electro power as direct current using A.C. to D.C. and vice-versa and convertors at the sending and receiving ends of the distribution cables. These convertors use bidion triggered spark gaps and are capable of dealing with both high currents and high voltages similtaneously as opposed to other known forms of convertors. Convertors handling 120 KV 200 amps have been made. A detailed report by Prof. Marx on the subject is now being translated into English. Arrangements were made for a copy of this translation to be sent to CAFT Group 1, 21 A.G.

DATE: 24 July 45.

INVESTIGATOR: S/Ldr. G.C. Barker MAP
Army Group 21
CIOS Group 1.

CIOS - CAFT GROUP 1 ASSESSMENT REPORT

FULL TITLE OF TARGET: Institut fur Elek Autogen und Steuerung Techn Hochschute, Hannover.

LOCATION: Lautenthal, Prinzess Caroline.

REMARKS:

Prof. Dr. Weissmann the head of this senall department was not available owing to illness. The following information was obtained from his assistant Dipl.Ing. Guiuher.

A small amount of work had been carried out by this Institut for the Wehrmacht.

(a) On the development of electrical control mechanism for machine tools.

(b) On the development of an electrical fuse for A.A. shells. This fuse consisted of one condensor which was charged at the moment of firing to a predetermined octential. Another condensor is then charged from the condensor via a suitable resistance and then the striking of a gas discharge lamp across this second condensor fires the fuse. The fuse, which was to be made by Rheinmetall Borsig under the name Ersatzzeitzunder ZS/30, was still under development tests still being made to find electrical components of the required stability and accuracy.

See Sim

DATE: 27 July 45

INVESTIGATORS NAME: S/L G.C. Barker MAP
Army Group 21
CIOS Group 1.

CIOS - CAFT GROUP 1 INTERROGATION REPORT

TITLE: Dr. Fritz Sennheiser

Senn

LOCATION: Institut fur Hochfrequenz und Electro-acustik, Technische Hochschule Hannover, Wolfengarten, Hannover.
or Forschungsstelle des Institut für Hochfrequenz und Elektroakustik, Wennebostel near Bissendorf.
or Westerfeld, Im Buchholz felde 13(Private address)

REMARKS: Dr. Sennheiser had acted as second in charge to Prof. Vierling the head of the Institut.

Prof. Vierling (now at Ebermannstadt near Nurnberg) and Dr. Sennheiser had both come from the Heinrich Herrz Institut Berlin to Hannover when the Institut fur Hochfrequenz und Electroacuehk was formed as a separate department in 1938. The salaries for members of the staff of the high school were inadequate, a Dipl.Ing was paid 150 marks a month during the war, and Prof. Vierling had augmented his salary by establishing two private laboratories.

(1) the forschungstelle des Inst. established in 1939.
(2) the Feuerstein laboratory at Ebermannstadt, near Nurnberg, established in 1942.

Dr. Sennheiser was in charge of the first of these and Prof. Vierling the second. Prof. Vierling was a member of the S.S. using this membership to obtain financial assistance and promotion. The work of the various laboratories is outlined below.

Institut, Technical High School.

Concerned solely with teaching.

Forschungstelle des Institut - Wennebostel

(1) Speech coding and decoding. Later transferred to Ebermannstadt.
(2) Development and production of cm oscillators for testing receivers such as Corfu. The small RD2M (g.d or h) Tellfunken magnetrous were used. These are quite conventional in design.
(3) Development and production of wavemetres for the 3-12cms bands using lechers and crystal detectors.
(4) Investigation of lighthouse oscillators in 25cm region.
(5) Development of a coded telegraphy system combining teletype-writers with a standard Lorentz "scrambler". The start and stop signals removed from Teletypewriters and synchronising of transmitter and receiver obtained by using quartz oscillators at either end.

SZ 40/42

Feverstein Laboratory - Ebermannstadt

Work on speech coding. Other work that Dr. Sennheiser does not know of. He believes that work on speech coding is being continued by the laboratory by arrangement with the occupying American Army.

DATE: 30 July 1945.

INVESTIGATORS NAME: S/L G.C. Barker MAP
Army Group 21
CIOS Group 1.

CIOS - CAFT GROUP 1 INTERROGATION REPORT

TITLE: Prof. Dr. Teches. Franz Unger

LOCATION: Hochschule, Braunschweig
and Braunschweig - Gliesmarode, Am Tafelacker 9.

REMARKS:

Prof. Unger is in charge of the Institut fur Elektrische Maschinen and during the war had been a technical officer in the German Navy working in Kiel, Berlin and Braunschweig. He had worked on the following problems.

(1) The diminution of the noise caused by machines used in submarines. In this connection he had designed a special DC to AC convertor for use with submarine compasses.
(2) The development of underwater arcs for metal cutting.
(3) The development of low weight electromagnets for magnetrous and also for mines.

DATE: 24 July 45.

INVESTIGATORS NAME: S/L G.C. Barker
Army Group 21
CIOS Group 1.

CIOS - CAFT GROUP 1 INTERROGATION REPORT

TITLE: Prof. Dr. Cario

LOCATION: Physikalisches Institut, Braunschweig Technical High School
or Braunschweig, Brauntager 9

REMARKS: Prof. Cario is Prof. of Physics at the technical High School Brunswick being appointed to that position in 1937. His interests lie in the fields of optics and atomic physics. During the war he did little work of importance having undertaken only the following problems.

(1) Work on the luminosity of the night sky for the Acad.L.F.F. The height of the luminescent layer had been determined as 110Kms and measurements were about to be made of the temperature of the layer by measuring the width of the sodium spectral lines.

(2) Development of optical instruments to facilitate the adjustment of moving coil metres.

(3) The reduction of the U.V. fluorescence of the oil films for the Forschungsgemeinschaft. He wanted to find a substance which would suppress the fluorescence of naval fuels. Time however did not permit of such an investigation and work was confined to the study of the effectiveness of dyes produced by I.G. Farben in absorbing the fluorescence.

(4) The development of a photo-electric apparatus for the rapid testing of optical lens etc. This was being developed for the Voigtlander Fabrik in Brunswick.

DATE: 26 July 45

INVESTIGATORS NAME: S/L G.C. Barker MAP
Army Group 21
CIOS Group 1.

CIOS - CAFT GROUP 1 INTERROGATION REPORT

TITLE: Prof. Dr. Seiz

LOCATION: "T" Force Camp, Gandersheim

REMARKS: Prof. Seiz was the head of the Institut für Electro maschinen Bauen und Hochspannungs technik, Technische Hochschule Danzig. He had done no work of great importance during the war. The various items that he had been connected with are listed below.

(1) Suppression of Radio interference caused by static discharges for the Reich Luftfahrt Ministry.

(2) Development of an induction furnace using spark gaps only just started (Reichforschungsrat).

(3) Distribution of electric power as D.C. - small scale experiments made.

(4) Production of large acoustic power in water for NVK. Work only just commenced and did not know purpose.
No connection with atomic research.

DATE: 28 July 45

INVESTIGATORS NAME: S/L G.C. Barker MAP
Army Group 21
CIOS Group 1.

CIOS ADVANCE FIELD TEAM REPORT.

TO: CAPT Team Leader (Group I) Go G(T)& CW, 21 Army Group Main.

Opportunity Targets:

The University LEIDEN and the University AMSTERDAM.

Further enquiries were made regarding the work of Dr. BUTCHER of the German S.S. at both LEIDEN and AMSTERDAM and the following is a summary of the information collected.

I. From Dr. J.VAN DEN HANDEL (KAMERLINGH-ONNES LABORATORIUM) LEIDEN. BUTCHER came to the University of LEIDEN in 1942-1943 from the Russian front, apparently to replace another officer who had to leave LEIDEN. He took a laboratory and professed to be engaged on work of interest to himself only, although as time went on it became more and more obvious that he had authority from high officials of the S.S. for obtaining materials etc. and was therefore engaged in important work for the S.S.

When BUTCHER went to DOETINCHEM he took with him a considerable amount of equipment including the following:

A Neutron Generator (from the University at AMSTERDAM).
Two powerful electromagnets (from LEIDEN) giving a field of about 18000 Gauss.
High Tension Transformers.
Electrometers.
Spectrograph, a glass one (a quartz one was available but was not taken.)
A Monochromator.
A Photometer was specially asked for but one was not available.

Dr. VAN DEN HANDEL did not know precisely what BUTCHER had been doing or was to do at DOETINCHEM, but he (and others of the staff) suspected the work was connected with atomic disintegration and the possible development of a "Uranium Bomb".

The following names were given of people who might be able to furnish further information:-

LISE MEITNER - a Jewess formerly working in Berlin - has done much work on radioactivity and atomic physics generally. No address given. May be out of the country now.

PROF.CASIMIR - UIVERLAAN 2 EINDHOVEN.

PROF.SIZOO of the VRIJE UNIVERSITEIT AMSTERDAM
(Laressestraat 174)
Had to provide a Neutron Generator.

II. PROF. SIZOO of the VRIJE UNIVERSITEIT AMSTERDAM supplied the following information regarding BUTCHER:

BUTCHER'S early work was on light alloys and he had been making X ray investigations. PROF. VON STOKAR, the former German head of Education in APELDOORN had told Prof. SIZOO that BUTCHER was working in Holland because a very important institute in Germany had been bombed (thought to be an S.S. institute) and BUTCHER apparently had great plans for rebuilding this institute in Doetinchem. STOKAR also said that BUTCHER was working under the auspices of a research organisation controlled by GORING. When asked about the nature of the work, STOKAR would give very little information but did say to Prof. SIZOO "Das hangt mit neuem Waffen zusammen" (It has to do with new weapons). When asked by Prof. SIZOO why his Neutron generator must be taken by BUTCHER, STOKAR had inferred that the Germans were getting as many of these generators as they could; he also said that the installation of Prof. JOLIOT in PARIS (Mme. Curie Laboratory) was being used by the Germans, mentioned installations in COLOGNE and BERLIN and also said that two Neutron generators working with 1,000,000 Volts had been made in HAMBURG (MULLER factory) but one of them had been destroyed. Prof. SIZOO was impressed by the fact that STOKAR - a classical scholar - should know so much about the distribution of these equipments in Europe, and concluded that the S.S. placed high importance on obtaining Neutron generators. LFA?

Prof. SIZOO'S own opinion on the subject generally was that neither the German nor Dutch expert scientists considered the discovering of a powerful new weapon using atomic energy likely in the near future, but that the German S.S. had great faith in such a discovery eventually, thence they were trying to promote the maximum of research work in this direction. The propaganda value of the investigations was also probably very high in certain circles in Germany. Prof. SIZOO had not a very high opinion of BUTCHER'S capabilities and was certain that he had not achieved any measure of success either at LEIDEN or DOETINCHEM. It was suggested by Prof. SIZOO that information regarding the attitude of the S.S. to the subject generally and also further information on what has been done in producing NEUTRON and CYCLOTRAN generators could be obtained from the former Chief of the Rontgen dept. of PHILIPS, Dr. BOUWERS now with the OPTISCHE INDUSTRIE, OUDE DELFT.

DATE OF ASSESSMENT 14 May 1945.

ASSESSOR'S (NAME'S) F.W. Trenouth, Capt. REME. Army Group 21.

C.I.O.S. INVESTIGATION REPORT

TITLE: Universitaets Institut for Teoretisk Fysik
KØBENHAVN
(Nøbls' Bohr Institut)
Niels

LOCATION: Blegdamsveg 15, Copenhagen, Denmark.

PERSONNEL: No German personnel.
Danish personnel:
Dr. Bøggild (at Institute)
Prof. Møller
Prof. Jacobsen
Dr. Koch
Prof. Bjerge (at Technical High School)

DATE OF INVESTIGATION: June 29th - July 2nd 1945.

HISTORICAL. The German authorities in no way interfered with the work of the Institute from the time of the occupation of Denmark until Dec.1943. During this period the work at the Institute was normal continuation of the pre-war work on the field of Nuclear Physics. One or two visits were made to Copenhagen by German Physicists, in particular Bothe visited the Institute in Dec. 1943 and Heisenberg, Weisachen and others made visits but no requests for any particular work to be done. In Dec.1943 Prof. N. Bohr, the Director of the Institute, escaped from Denmark to allied territory via Sweden. This event apparently aroused the suspicions of the German authorities, who used it as a reason or excuse to occupy the Institute and imprison the deputy director, Dr. Bøggild, for two months. The Danes were told that a German Scientist (Dr. Weizacher was mentioned) would in future run the establishment.

Negotiations took place between Dr. Heisenberg, who revisited the Institute shortly after Prof. Bohrs departure, Dr. Best (German Diplomatic representative in Denmark) and the Head of the University in Copenhagen; and after repeated refusals on the part of the Danish physicists to work under terms dictated by the Germans, the Institute was handed back to them unconditionally.

Whilst it had been occupied by Gestapo personnel no damage had been done to the Institute and there was only minor looting of articles of immediate commercial value (cameras, etc.) The equipment as a whole was undisturbed. Since 1944 there has been no attempt to control or interfere with the work of the Institute which has been engaged in nuclear physics problems using techniques which were already quite familiar in 1939.

EQUIPMENT. The main equipment of the Institute is as follows:-

1. A cyclotron with a 37 ton magnet. Pole faces 90 cm, diam, max field 20,000 ørsted, capable of producing electron beams of up to 10 m.ev. The original construction is described in a publication Det. Kgl. Denske Vedenskabennes Selskab (D.K.D.V.S.) Math-Fys Med xix. 2. 1941. J.C. Jacobsen. Since that report was written the H.F. circuit and other details have been seriously modified, including the use of 14 stubs to support the D's and so obviate the use of insulating materials. The triodes producing the 25 meter oscillation are continuously pumped and are in the same vacuum envelope as the main cyclotron. The equipment has been used to produce fission products of Uranium which have then been the subject of further study. (D.K.D.V.S.) Math-Fys Med xix 6, J.C. Jacobsen & N.O. Jassen.

2. A more or less converted D.C. high voltage equipment which has a maximum working voltage of 0.8 m.e.v. Described in detail in D.K.V.S. Math Fys Med xviii 1 J.K.Bøggild, K.J. Brostrøm, T.Lauristen.

3. A pressurized Van de Graaff machine for about 3 m.e.v. working at a pressure of some 8-10 atmospheres. The method of construction seemed to follow more or less conventional lines.

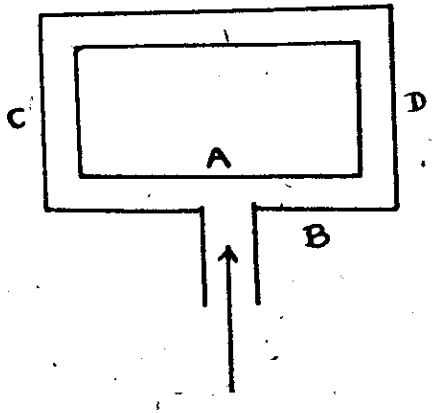
4. A mass Spectrograph of large "Effective aperture" and high resolution designed for producing samples of separated isotopes, particularly U235, for nuclear experiments. Particular attention had been paid to the design of a low voltage ion source to maintain the resolution at a high value. Details are given in a Doctorate thesis of D.T. Koch ("Massesspectrografiak and Isotopadskillelse," København, 1942) and in D.K.D.V.S. Math Fys Med xxi No.8 1944, J..Koch and B. Benot-Nielsen.

The new mass spectrograph was capable of resolving clearly isotopes differing in mass by 1 part in 200. 90° magnetic focussing of radius 80 cm of a carefully formed beam (electrostatic focussing) was employed. Xenon is the heaviest element successfully separated so far, and the main problem of the moment was the development of suitable uranium compounds for use in the ion-generator which would give a good yield of atomic uranium ions.

Other experimental work which had been done included measurements of the ionisation and range of the fission particles of Uranium (early work in D.K.D.V.S. Math Fys Med xviii 4 J.Bøggild, J. Brostrøm and T. Lauritzen 1940). Experiments were being made to discover the number of electrons carried away with the fission fragments, the change of charge on the fragments as it is stopped in a gas, and the relation between charge and size of the particle.

Prof. Bohr had developed a theory of these processes but the experiments of Bøggild and others did not appear to agree with it.

Prof. Jacobsen had made a very interesting check of the recoil of Kr88 during B particle emission in order to establish the existence of the neutrino. Kr88, a product of U235 fission, is B radioactive yielding stable Strontium. The recoil of Rb88 was measured by collecting Rb88 (and measuring activity of deposit) in the apparatus shown:



Kr88 at low pressure

The outer box B in the sketch is filled with Radioactive Kr88 gas at about 10-4 mm pressure.

The inner box A is symmetrically placed in B but has one wall solid and the other fine gauze. It can be held at a D.C. potential positive with respect to A.

The Rb88 (B radioactive) deposit collecting on walls C,D is in part from the gas between A,B and for wall D includes the recoil atoms from volume A formed when the Kr88 emits a B particle (and neutrino?)

By placing a retarding potential between A & B and comparing activities at C,D the energy of this recoil can be estimated.

The results indicated a recoil energy of 51 e.v. which corresponds to the full B ray energy of 2-4 m.e.v. and suggest that the neutrino emitted simultaneously with the B particle in the same direction.

Prof. Jacobsen had also measured the decay constant of RaC[1] by a delayed coincidence recording method. (Published in D.K.D.V.S. Math Fys Med xx. N 11 1943 J.C.Jacobsen and Th. Sigurgeirsson).

The work of the institute as a whole was affected in part by lack of some materials but above all by the complete lack in the last few years of any contact with physicists of other countries. Apart from the inevitable rumours, the members of the Institute had no knowledge of the work of German or Allied Physicists on the Uranium fission problem, or for that matter in any other nuclear physics problems, published or otherwise, which had been done in England June 1940 or in U.S. June 1941.

They were rather eager for any scrap of information and were eagerly awaiting the return of Prof. Bohr, in order that their activities could be brought in line with activities in other countries.

Army Group 21
C.I.O.S. Group I

S. Devans, Sq. Ldr.
12 July 1945.

CIOS INVESTIGATOR'S PRELIMINARY REPORT

TARGET Opportunity

TARGET Mathematische Reichinstitut

LOCATION Lorenzenhof, Oberwalfach.

DATE 6th July, 1945.

TYPE OF TARGET Centre for mathematical research.

CONDITION OF TARGET Intact, and under protection of Military Government, Fribourg. Freiburg!

REPORT

The Institute was set up early in 1945 under the auspices of the Reichs Forschungarat; its terms of reference are as follows. To further mathematical research by

1. Arranging conferences between specialists.
2. Co-opting distinguished scientists to work at the institute.
3. Financing suitable research work elsewhere.
4. Furthering mathematical knowledge at universities by providing suitable lectures and literature.

Organisation of Institute:

Director Prof. W. Suss (Prof. of mathematics, Rektor, Freiburg University)

Deputy Directors: Prof. E. Sperner and Prof. W. Threlfall.

Amongst the members of the Institute were:

Prof. H. Behnke, Münster.
Prof. H. Seifert, Heidelberg.
Prof. H. Gortler, Freiburg.
Prof. G. Bol. Greifswald.

Contracts from RFR sponsored by the Institute included:-

Gortler and Mangler	Boundary layer theory	(Monograph)
Kamke	Catalogue of mathematical tables	"
Collatz	Numerical treatment of vibration problems	"
Schmeidler	Integral equations	"
Seifert-Threlfall	Hypergeometric function	"
Magnus	Dictionary of mathematical formulae	"
Hermann Schmidt	Asymptotic Expansions	"
Magnus-Bucholz	Confluent Hypergeometric Functions	"
Kamke	Partial differential equations	"

Sperner	Long range weather forecasting (Monograph)
H. Schmidt-Obaier	Mathematics of Servo Mechanisms. "

It appears that very little work of immediate application was carried out, the efforts being almost entirely devoted to the furtherance of theory. Information about many other centres of research was disclosed during interrogation.

5. Owing to a temporary dispersal of part of the Institute it has not been possible to interrogate the following:- Seifert, Schmidt, Buchole, Baier and Schneidler. Interrogations of these and a further interrogation of Prof. Sperner by an expert meteorologist appears desirable.

Lt. Cmdr. Todd. R.N.V.R.
Lt. Reuter R.N.V.R.

T. F. & S. LTD., NOTTM.