Location of Industry: Moscow

Political Location: Moscow Oblast'

Descriptive Name: Inst. of Communications Techniques

Proper Name: Scientific Testing and Research Institute for Communications Techniques

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Location of the Institute:

In the town of Mytishkhi, North of Moscow. It covers two separate areas. The main building is at an altitude of 160 m, approximately 1.5 km North of the Mytishkhi R.R. station. The secondary building is about 1.5 km East of the main building.

Purpose of the Institute:

To develop communications equipment for the Army, with the aid of captured German material and foreign research data.

Security:

Both areas of the Institute are surrounded by fenses. The fenses are partially of boards, with barbed wire on top, and partially plain barbed-wire fenses. There are many watchtowers. At night the fenses are guarded by dogs and lighted by searchlights. The Red Army supplies the guard personnel.

Other information:

There are many antennas erected on the Institute grounds. A dismantled UHF transmitter is stored on the grounds of the main building. This transmitter is of German origin. The steel mast has been disassembled. The antenna is a 5.5 m wavelength dipole.

The total number of personnel of the Institute is approximately 2000. The engineering staff is made up entirely of officers. Details are given further below.

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Report on the PW laboratory of the Institute for Communications Technique of the Red Army

1) The PW laboratory was a special unit of the PW Camp No. 7027, Moscow - Krasnogorsk. It was formed on 15 October 1945. Its complement varied between 25 and 30 men. Most of them were engineers, technicians and mechanics with special training in communications technique (particularly HF work).

2) The first work site of the PW's of the above laboratory ~~xxxx~~from October 1945 to February 1947 was in the town of Tarasovskaya, on the grounds of a former summer camp of the Communist Youth Organisation. The Institute supplied the material and the measuring equipment, about 90% of which was captured German material. The measuring equipment of Russian origin, which was supplied later on during this period, was small in quantity and contained no instruments which were modern, handy, and suitable for more than basic purposes. Modern apparatus did not appear until the middle of 1947, all of them copies of German models. The German models had been copied so painstakingly that the products of well-known German firms, such as Rohde & Schwarz, Dr. Steeg & Reuter, and Telefunken, could be easily recognised. ~~xxxxxxxxx~~ Apparatus of British and American origin was also available.

3) The work unit was formed for two ~~xxxxxxx~~ purposes. The first was to repair captured German military and laboratory equipment, the second - and probably main purpose - was to get the non-existent Russian decimeter wave technique into shape. This was the reason why I was flown to Moscow from Berlin. During the first six months of my activity there I served as a living encyclopedia for decimeter technique. The volume and the type of questions which I was asked, and the conclusions and opinions formed by my questioners on the basis of my answers gave a very clear picture of the Russian state of development in the field of decimeter technique. I cannot believe that I was told the most nonsensical technical things in the shrewdest manner imaginable, just so that I would form mistaken opinions of the Russians. However, it must be said that the Russians have a special gift of finding their way around in what they have and ~~xxxxxx~~ of making good use of it. They did not show any notable creative ability, however.

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4) During this first half year I was to show some initiative build "something new" for the Russians. For this purpose I developed the project of a "Universal Decimeter Measuring Set ". I based the project on the German data which the Russians had captured and to which I had access (some of these data were my own work) and combined a number of measuring and compensating devices for decimeter waves into one apparatus. My idea was not to develop the project xxxxx beyond the bases of the captured material. Finally this quite absurd project of mine was approved by the Russians at a technical conference for which they had brought all kinds of experts from near and from far away, and construction was to start, or, at least, the actual design work was to be undertaken. During the period following this, however, they lost interest for various reasons. One of the reasons was that the whole project took too much time, and a further reasons was the insolvable difficulty of supplying material. Furthermore, the mechanical workshop of the Institute was practically on the zero level. Machinery and tools did not even nearly fulfill the requirements for a mechanical or precision shop for high-frequency work. In other words, the project was never carried out. It did not get beyond the primary stage. Ix It is significant, however, that a project such as this was approved by a conference of experts in the first place.

5) In this connection, a few words should be said about the question of materials, semi-finished products, and tools. The question of raw materials is one of the most unpleasant ones in xxxxx Russia. All non-ferrous metals are critical items. Steel- and iron alloys, including - or inxx particular - tool steels, are of the very poorest quality. Shipments of raw materials in the form of semi-finished products are almost unknown, and whenever materials are supplied in that form, their state is xxx poor as to be indescribable. The tools of Russian manufacture are all inferior, and anyone who by accident has managed to get hold of American or German tools guards them jealously. It is typical that the workshop of the Institute had only two sets of M 3 thread drills during the entire 2½ years I spent there. For that reason, the weirdest expedient solutions are required of designers to get around such difficulties. Generally speaking, the laboratories are in no position whatsoever to carry out continuous and xxxxxx unimpeded work, because the above difficulties provide stumbling blocks wherever one turns. This

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state of affairs probably has not been improved very greatly since then, because during by later work in the factory at Khovrino I noticed the same situation.

6) After the project of the Universal Meter had petered out, the Russians hit upon the idea which was closest related to it: They wanted their own oscillator for the decimeter range, so that they might be able to carry on experiments at all. Besides, the Institute had received a few German metal-ceramics tubes of types LD9, LD 10, and LD 11. I was given the order of constructing an oscillator for the 30 cm range, using a metal-ceramics tube and a concentric wave guide. On the basis of my collected data I designed the set, disregarding bottlenecks in materials or production. This project, too, was badly delayed.

7) In the meantime, the Institute had gotten hold of a project, worked out still during the war by a certain Dr. Meinke of Telefunken. It was a device for carrier-frequency multi-channel telephony on pulse-modulated 20 cm waves. The HF stage of the transmitter was shown to me for evaluation, while I did not even know what the set was to be used for or who had designed it. These things came out only later on, bit by bit.

At the same time (February 1947) the work site of our unit was moved to the immediate vicinity of the Institute, to facilitate liaison.

This already quite sizable project was taken over by the Russians all by themselves. One of the reasons was probably their desire to keep it secret, the other reason was the fact that they had had their own "experiences" with the PW laboratory.

The final design of this project was carried out by the firm of Lorenz, Berlin. We saw the blueprints, made from the German originals with German standards. They were only the blueprints of individual mechanical parts, which were then made in our shop. Circuit diagrams and data on the mechanical assembly were not issued to us. However, smaller electrical assembly units were assigned to us, such as filters, carrier-frequency oscillators, amplifiers, and above all, power packs, auxiliary equipment, measuring devices, measuring accessories, and various types of oscilloscopes for pulse observation and measurement.

8) Naturally, it was difficult to get an over-all idea of the project from

these fragments, especially since we had to carry out other work at the same time. Furthermore, the Russians had peculiar tactics, and openly admitted it: The data for the electrical elements or assembly parts which they ordered from us were ordered with altered specifications. For example, they ordered a carrier-frequency oscillator, while they were really interested only in the basic design, the circuit diagram, the types of tubes used, and the dimensions of the circuit elements. Afterwards, they built the oscillator they really wanted in their own laboratories. However, every time they copied our work in this manner, the result was a long series of questions to us, because their model did not function properly. In these questions, they always tried to obtain the most voluminous and detailed data on the methods of calculating and dimensioning of the circuit. The fact that they would request the the bases for the calculation of circuiting arrangements which no person with any sense would calculate shows that had not grasped the idea, but that they were quite at sea - and probably still are.

9) The above device contained, among other elements, a 20- pole electronic switch (made by Lorenz) for the distribution and filtering of the voices. As already mentioned, the device was to operate in the 20 cm range, at a continuous-dash power of 100 W, and a keying ratio of 1 : 10. A so-called locking transmitter was provided for exciting the pulses with coherent HF oscillations. The transmitter was equipped with German LD-type metal-ceramics tubes which are/now probably being made by the Russians themselves. Even then already I saw a striking model of one of these tubes which was obviously a slightly modified copy. The whole device was to be installed in German-designed light-metal cases with drawers, and was to be used by the Army. Our shop was given the unfinished cast-iron and sheet-metal parts for processing. They were of German post-war manufacture, but the name of the manufacturer could not be determined. The pulses sent out had a duration of 1 to 1.5 microseconds and a frequency of 10 kc. They were phase-modulated. The Russians intended to use this device not only for long-distance but also for local communications For that purpose they had large transit-time chains and phase displacers built, in order to unify the transit times of the different transmitter ranges, so that the entire unit would operate synchronously.

10) However, due to the ignorance and the uncertainty of the Russian engineers,

plus the notorious shortages of materials, the project was still in the embryonic stage after a space of over one year, despite assiduous efforts. In the meantime, the original project had also been modified several times, in order to overcome some difficulties whose nature is not known to me. The result, as was once confided to me, was that nobody could possibly find his way through the wild confusion of alternate designs.

11) At this point, a few words on the level of proficiency of Russian engineers seem appropriate. Two young graduates of an Institute of Technology were assigned to me at that time, as it was stated, in order that they might learn German laboratory practices. From their examples I could easily tell the quality of training given to young Russian engineers. These two young men had been trained only in high-frequency technique. Their knowledge comprised a great deal of high-frequency technique and a lot of mathematics. However, their knowledge of high-frequency work stemmed only from books, and they had no laboratory experience whatsoever. Ability to carry out manual and experimental work was completely lacking. During ~~the course of~~ a fairly long period I took the opportunity of sounding them out. To my surprise I discovered that they had only very foggy notions of the large field of power current technique. For example, they knew either nothing at all or only very little about electric motors. They had no clear picture of the different types of electric motors, their properties and their operational characteristics. The easiest design project was above them. First of all, they knew nothing about the possibilities and the limits of the mechanical processing of materials, and secondly, the sketches and drawings they turned in were so indescribably bad, both in respect to ideas and to execution, that they caused errors of large proportions when supplied to the workshops. Their training in general physics was likewise very sketchy. In general, their engineering training suffered from premature specialization.

12) I should like to say a few words about the methods used by the designing office of the institute. (The same applies to the designing office of the factory where I spent the second part of my captivity in Russia.) All drawings, as a matter of principle, were made on pasteboard. The method of drafting on tracing paper is considered "unsound" by Russian designers. Since no blueprints could be made of them

these drawings, each shop copy had to be made by hand. But here again, they refused to use tracing paper, so that each drawing had to be done over, with the original serving as a model. When the shop had completed the order, the drawing was not returned to the designing office, but, provided it could still be used, remained in the paymaster's office as document. Thus, whenever, a shop order was to be filled again, the drawing had to be copied by hand all over again. On top of this, there was no sensible system for numbering of sets of drawings. A subdivision of a design project according to nomenclature, with the project divided into assembly groups and subgroups, could not be carried out. All assembly drawings were numbered in the chronological sequence of their completion, starting with "1", so that the drawing of one individual part could not be assigned a certain place in the design according to number. As a further oddity it should be mentioned that the Russian designers crowd their assembly drawings with parts hidden from view, so that it is difficult to decipher the drawings with their welter of dotted lines. The drawings thus show a remote resemblance to the dress patterns published in fashion magazines.

13) Russian scientific literature is full of misprints. The errata are listed only in very rare cases. All issues up to 1947 (not only the wartime publications) are marked by the poor and wholly unsuitable quality of the paper and the abominable print. Slanting printing blocks and misplaced columns in tables are no rarity. It must be said, however, that, starting with 1947, the quality has improved by leaps and bounds. Typical for this are the extensive source references, 90% of which are foreign. This is an open contradiction to the statement found in every preface about the autarchy and independence of Russian science.

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Questionnaire

1) What are the working methods of the Institute?

A.: The individual engineer or the work group is given an order, which it then works out in a so-called preliminary project. This preliminary project is then submitted to the higher authority of the Institute, which makes a preliminary examination and then calls for a technical conference. At this conference, to which a number of technical experts are invited, the designer has to "defend" his project. This defense is followed by a long discussion, and then a vote is taken on the practicability of the idea and on the question of the method of construction. At this stage, the work schedule, modifications of the preliminary project, and detailed deadlines are definitely set. The designer must absolutely follow the content of this "resolution". He is ordered to build a prototype model. The administration of the Institute must be kept informed on the progress of the work at regular intervals. When the work on the prototype has been completed, another conference for evaluation is called. This conference judges the success of the model and decides on any eventual modifications. The project is thus ready for full production. The designer has to surrender all data, including personal notes. All these discussions are public for all members of the Institute. They are attended by members of the political department. In case of failures or delays they have the final word, after listening to the experts' testimony. According to my observations and experiences, this method is a handicap to creative ability, since the resolutions of the technical conference represent a block to individual opinion and initiative. It may happen that the designer has to work against his better judgment. Deviations from the "line of the resolution" are very dangerous. It is in the nature of this matter that the presence of well-known or famous experts at the discussion and at the subsequent balloting, which is not secret, has a decisive effect on the forming of opinions. A little laboratory or department chief will hardly oppose his high superiors in an open balloting. Thus, there is nothing to prevent miscarriages of justice in the technical field.

Miscellaneous information: The requirements of raw materials, semi-finished and finished products are determined in advance in the yearly plan. If one of the

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project chiefs finds it necessary to carry out his work not in accordance with the plan, great difficulties arise. Grotesque expedient solutions and designs are often resorted to in order to "remain within the plan". Likewise, nearly insurmountable difficulties occur in the procurement of rare materials, such as special chemicals, which are not being produced by the sources of supply assigned to the institute.

The amount of waste in the mechanical shops, due to lack of trained personnel and suitable machines and tools, is unimaginable. However, this does not seem to worry anyone, since precision work is considered particularly difficult and tricky. Tolerances and machining specifications are principally not adhered to. Hard and soft soldering of complicated designs (especially the brass parts of decimeter wave apparatus) is altogether impossible. As an expedient, such elements, often consisting of telescoped tubes, are turned and milled from a solid piece, with a great amount of material wasted.

Q.2: Names of Russian Engineers and Scientists at the Institute, with Data on Their Training and Activity.

A: Technical chief of the Institute: Engr. Col. Sosunov. Speaks a little English, does not speak German, probably has no training abroad.

Department chiefs: Department for decimeter measuring technique: Probably Lt. Col. Itkon. Other data same as above.

Department of decimeter apparatus design: Maj. Saposhnikov. Speaks perfect German and English, attended the Berlin Institute of Technology.

Department of decimeter apparatus design or Technical Staff of Institute Administration: Maj. Sievers, speaks perfect German and English, is probably of Baltic origin, most likely trained abroad.

Title of position not known: Maj. Forstmann, speaks good English, a little German, has probably lived in England. Was Transferred to Leningrad.

Q.3: Which is the superior authority of the Institute?

A: The Institute is directly under the administration of the Ministry of War.

Q.4: Is the Institute guarded by military personnel?

A: It is considered a military establishment. It is fenced in, provided with watch towers, and has guard detachments.

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Q. 5 : Is the Institute visited by inspecting commissions?

A. : Only by inspecting commissions of the Ministry of War.

Q. 6: Is the Institute connected with any other similar institution?

A.: There is a similar institute at Leningrad, with which personnel is frequently exchanged.

Q. 7: What kind of research is carried out? How is the Institute organised?

A: During my stay there, basic research was restricted to the exploitation of foreign material.

The main task, however, is probably the development of apparatus and the testing of the apparatus designed for the Army with the military personnel of the Institute.

The Chief of the Institute is a General (only the military administrator, not an engineer. His name is not known.) He is assisted by a technical staff (cf. Question 2). The further division of the Institute is according to departments, each with a different field of work. The departments are subdivided into the individual laboratories and technical offices. The engineers of the Institute are nearly all officers. Civilians are employed only in the workshops and in subordinate positions.

The telephone directory of the Institute lists 400 to 500 numbers.

Q. 8: Detailed description of the apparatus built and tested at the Institute, if possible, with circuit diagrams.

Answer not given.

Q. 9. : Is research carried out only for the Army or also for civilian and commercial purposes?

A.: Probably primarily for military purposes. As far as I know, no work for commercial purposes is being carried out, but I am not positive.

Q. 10: What is the equipment of the barracks in which the PW's worked.

A: The PW laboratory was a large subterranean bunker which previously housed troops and is now again used for this purpose. The PW built all the equipment, and when they left, this equipment was removed. Besides this, and the furniture, there was no equipment in the barracks.

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Q.11: Names of the PWEs who worked in the barracks, their specialties and previous employment.

A.:

Name	Profession or title	Field	former employ	location	now at
Max Kelscher	Dr. rer. nat.	Mathematician	V-2 testing grounds	Peenemuende	Darmstadt
? Wiechowski	Dr. Ing.	Prof. of theor. electr. engrng.	Inst. of Tech., Prague	Prague	?
Heinz Froehlich	Dr. Ing.	high-speed internal combustion engines	Brennabor	Berlin-Pankow	?
Clemens Filbert	Engr.	electric motors	independent	Frankfurt a. M.	
Heinz Lamperski	Engr.	machine constr.	Mauser	Oberstdorf	same
Heinz Okunek	Engr.	High frequency	GAF	?	Westphalia ?
Werner Salm	Engr.	High frequency	?	?	French zone
Paul Bosserhardt	Engr.	Machine constr., wind power machines	?	Stuttgart	Stuttgart?
Heinz Kloid	Engr.	Carrier frequency	Siemens	Berlin	?
Heinz Melchert	Engr.?	Power current	Siemens	Berlin	Berlin?
Hans Malinowsky	Engr.	Power current	Siemens, GAF	Berlin-Spandau	same?
Heinz Schwarz	Engr.	High frequency	Air Min.	Berlin	?
Hans Fuhrmann	M.D.	-	-	?	Brit. zone
Fred Minini	Bricklayer, chimney builder		?	Cologne	same
Heinz Schwarz	Electromechanic		Telefunken	Berlin	?
Hans Hass	Auto mechanic		?	?	Sovzone
Fritz Marker	Telephone lineman		City	Speyer	Speyer?
Heinz Gleisberg	Master mechanic	X	?	Dresden	Dresden
Werner Breuer	Lathe operator		?	Berlin (US sector)	same
Heinz Pavel	Cook		?	?	Sovzone

Q. 12 : Did any PW's sign long-term contracts? If so, who did and for how long?

A.: Until the middle of 1947, the Russians kept trying to sound out the prisoners on the attitude toward the signing of contracts. In one case this matter had reached a fairly definite stage, but then all these efforts were called off on orders from above. The new policy prohibited the signing of contracts while on PW status. The PW's were repatriated and could apply to the Soviets for a work contract only after they had registered with their own local authorities.

I have hearsay information, that PW's in camp 7027 were to sign contracts in 1946. They were given personal papers and work contracts for signature. These personal papers gave the PW's citizenship as "stateless". They Russians, when questioned about this, are said to have explained that this was only right and proper since there was no such thing as a German State.

Q. 13: Were PW's with special qualifications transferred to another camp for different kinds of work?

A.: In the spring of 1946 our group contained a certain Dr. Heinz Froehlich, of Berlin-Pankow, a specialist in the field of high-speed internal combustion engines. He wound up in our high-frequency group by mistake, and was taken back to the camp after a while. Reportedly he was sent to the Caucasus shortly afterward.

Q. 14: What is the present status in the field of high-frequency technique?

A. : xxxxxx

General:

Raw materials and semi-finished products: The requirements of high-frequency technique seem to figure in production plans either not at all or only to a very limited extent. Non-ferrous metal sheets and profiles are available only with difficulty and only every now and then. Aluminum and light metal alloys appear to be reserved for the aircraft industry.

The synthetic resins for use in HF technique are of very poor quality.

Semi-finished and finished parts: The supplying industry produces only parts for low-frequency technique and for broadcast-band and long-wave reception technique. All material not in these categories is of foreign origin. (A factory at

Tabkkont produces water-cooled transmitter tubes with outputs of 15 and 25 kW.) The industry, however, is in no way able to meet the demand. American lend-lease shipments and captured German stocks still play an important role.

Furthermore, there is a total lack of precision-built mechanical construction elements, such as nuts, screws, washers, splints, etc.

Personnel: [illegible] I never met any specially trained mechanics for high-frequency or low-frequency work. There are quite a few people who call themselves"specialists"in one field or another, but their "specialty" is never their real field. They perform this type of work because they used to be working in similar fields before. Of course, nobody takes any serious interest in their further training or education.

Technical drafting personnel and other technicians are given short training courses and are thus on the level of apprentices.

On engineering personnel cf. Question 25. On technical data cf. Question 17.

Broadcasting: Russian broadcast receivers are not marked by good tone quality. Fidelity is not considered important. Loudspeaker console models are unknown. The main thing in receivers is the volume. Automatic fine tuning and push-button tuning devices were not observed. The mechanical construction is coarse and faulty.

Political aspects: I repaired or rebuilt hundreds of radio receivers. The rebuilding generally consisted in the installing of a short-wave receiver. In that case I was always asked, more or less confidentially, whether the set would now receive London, on what wavelength and at what times London was broadcasting. The listening to non-Russian stations, as is known, is not allowed, or will cause trouble for the listener with the political authorities.

Russian radio receivers are in no way able to compete with European or American products.

Television: Moscow has a television transmitter, which at present broadcasts only experimentally. The quality of the broadcasts varies greatly within one program. The faults, in order of their magnitude and frequency of occurrence, are the following: Three-dimensional appearance, black-and-white images, poorly focused zones, barrel distortions and pincushion distortions of images. Moving pictures are televised without a fading mixer. Studio telecasts have poor depth focusing. The transmitter has to warm up for about half an hour before it will operate with a fair degree of stability. Its tone quality is good. Its transmitting frequency is approximately 50 mc, with a distance of 8 mc between audio and video. The Russian CR tubes are strongly convex, with a screen diameter of about 25 cm. The color of the image is greenish. The television experiments date back as far as 1937, since I saw a receiver built in that year. The number of images is 25 per second, with about 350 lines per image. Work on the definite establishing of the number of images and lines has not yet been completed.

Low-frequency sets: The average person cannot afford to buy a radio receiver, since the cost is too high. Therefore, there are extensive wired radio networks in Russia, operating on low frequency. One village, for example, will have one single receiver and a power amplifier. The subscriber has a standard crystal loudspeaker which is comparatively inexpensive. Its tone quality is fantastically bad. Its construction is extremely primitive, and the materials used are unsuitable. Consequently, it is always in need of repair, especially since the individual parts are only hastily stuck together with ordinary glue. The radio receiver itself is usually maintained by the local Party headquarters, and permanently tuned to the broadcasting transmitter of the district. Subscribers pay a monthly fee. (Cf. drawing of the loudspeaker, appendix 11). For LF wired radio networks, and for factory intercom sets, a number of power transmitters with various outputs have been designed. My last job in Russia was the maintenance of one of these devices with a 500 W output. It was of rack construction. As everywhere else, here too, the electrical components were mostly of foreign origin, while the wiring was haphazard and with unsuitable material. The set, although it had been in operation only for a short time, had a tremendously high interference level and broke down at least three times a week. It was not reliable or safe by any means. In addition to ringing noises (created upon entering the amplifier room) and feedback noises in one amplifier, most of the interference consisted of AC hum. This was caused by the fact that the line transformers and the LF transformers had been arranged in a very thoughtless manner. This fault had to be eliminated by rebuilding. This too demonstrates the designers' ignorance of electrical requirements, and

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the inability of the consumers to offer any criticism. The moving-coil microphone belonging to the set was not safe from dust and mechanical damages, due to faulty construction. Furthermore, it was designed so badly that there was great danger of damaging the membrane and the coil every time it was taken apart. However, large loudspeakers of excellent construction are available for factory PA systems.

General: The quality level of the instruments and equipment in the laboratories undoubtedly provides a reliable measuring stick. (Cf. paragraph 2 of the first chapter). The level was very low and was raised only by the purchase of American equipment and by the obtaining of captured German stocks and by copying them. For instance, I saw no universal measuring equipment (Combination AC and DC voltmeters and ammeters) of Russian manufacture. There are, however, ammeters for 30 microamps, in cardboard housing. These instruments are found frequently. The pointer adjustment was fastened to the cardboard, so that the zero position would be displaced every time the instrument was moved. Measuring instruments for laboratory purposes in bakelite cases and soundly constructed have appeared only recently. The building of copied sets apparently has gone into full production during 1948 and 1949.

Q. 15.: What is the present state of radio telegraphy (decimeter waves)?

A.: In my opinion, there was no decimeter wave technique before the end of the war, as I stated before. This field may have been treated by a few Russian top experts, as far as it was available to them, but established Russian decimeter wave technique did not exist.

By now, they have probably gone through the very detailed technical and scientific captured data, so that the Russians should be at the German level of April 1945, at least as far as theory is concerned. Judging from my observations, the Russians made great efforts to develop practical applications for the captured data as quickly as possible, using a method which might be described as a "cook-book" method, which would allow them to develop a practicable device and to exploit the theoretical bases for designs of their own. However, my observations only go as far as April 1948, so that I cannot make any statements on developments after that time. It is a peculiar characteristic of the Russian method, that they were

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not interested in the physical Why and Wherefore, but that they wanted almost exclusively only "recipes" and definite operational instructions and dimensioning rules which could be put into practice at once.

Q. 16: What sets (type designation and technical characteristics) are used in radio telephony?

Answer not given.

Q. 17: What are the weak points of Russian equipment and what are the causes of these faults?

A.: a) High weight. The use of light metals and light metal alloys is almost completely prohibited. They are not sure of themselves in their designs, the cross-sections of their sheet and profiled metals are enormous, while improving the strength of sheet-metal parts by profiling is not a popular method. In general, ~~xxxxxxxxxx~~ deformation of parts is carried out by cutting rather than by non-cutting methods.

b) Lack of corrosion resistance. Since iron and iron alloys are used with preference and since surface treatment is neglected, corrosion is high. Nickel- and chrome plating are carried out only for appearance and thus are restricted to external parts.

c) Large size. No efforts could be detected of reducing the size of the apparatus by condensing the assembly parts and utilising empty space within the set. It is said, that this is not done because the telescoping of construction elements make construction impossibly difficult and because the manufacturing methods cannot cope with such problems.

d) Difficulty of repairing: According to the requirement that all designs must be as simple as possible, no effort is made of separating the individual electrical groups of an extensive circuit from each other. Instead of building sets with easily interchangeable elements, all kinds of parts of a circuit, no matter how heterogeneous they may be, are mounted on one and the same base plate.

e) Lack of construction material: During my activity at the Institute I discovered that screws, nuts, washers, splints, and electrical accessories such as jacks, plugs, cable shoes, soldering strips, and terminal strips, existed only on paper, where their industrial standards were specified, but that they could not be found in stock anywhere. All these items, although mass-production items, were manufactured by the corresponding industry individually and in quantities to fill one individual order. This has quite an adverse effect on interchangeability, especially since there are no thread gauges.

f) **Wiring material:** During the post-war years, the Institute used only captured German wiring material or American wire for HF and LF circuits. Of Russian wire I saw only the following: Enamel lacquer wire, with very inferior lacquer which cannot withstand the stretching and bending stresses occurring in the winding of a small transformer ; textile - rubber - copper lits wire, designed for the electrical system of motor vehicles, but with cross-sections much too large for use in HF equipment; textile- oil lacquer insulation jackets, with an interior diameter of no more than 2 mm, quality usually too poor for any uses, the inside usually hopelessly plugged with lacquer; plain copper wire of all sizes, but never either tin-plated or silver-plated; waxed wire with cotton thread wound around it.

All Russian equipment, including pre-war equipment, regardless of whether broadcasting equipment, laboratory or measuring devices, or military equipment, are wired with this material designed for minor low-voltage purposes and for automobile wiring. Synthetic resin insulators are regarded with suspicion, since the Russians consider them unsafe.

g) Shortage of ceramic and synthetic resin construction materials.

Ceramic materials or parts are practically unknown. The only ceramic product available is porcelain for power current purposes. These ceramics do not have dielectric values which render them suitable for high-frequency technique. The insulating material of organic origin, which is practically always available, is hard rubber, whose dielectric values also make it unfit for use in HF equipment. Recently, plates and rods of a synthetic resin (known in Germany as "Trolitul"), obviously imported from the Soviet Zone of Germany, have appeared. This material has values which allow its use even in UHF equipment.

h) Condensers:

Paper condensers: Very large size, very low operating voltages, very sensitive to overloading.

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Paper - oil condensers : Not known

Electrolyte condensers: Only those with semi-moist dielectric are known (wet ones are unknown). They have a very low voltage limit, are very sensitive to the slightest heat effect, have a very thin outer aluminum jacket, and corrode quickly.

Mica condensers: All kinds and all dimensions. All of excellent quality.

Trimming condensers: Air and ceramics trimmers are not known. The only ones in use are press trimmers with mica as dielectric.

Tuning condensers: Air gap variable condensers up to 500 μμf individually, and in sets of up to four are available. Mechanical construction is coarse and clumsy, the bearings are usually faulty. Synchronisation of sets at the factory is not carried out perfectly. The ~~scale~~ scale on the outer condenser plate for synchronous setting is coarse and does not fill requirements for good synchronisation. Variable condensers with mica or synthetic resin as dielectric and with capacitances above 500 μμf are unknown.

i) Line transformers and DC filter chokes:

Finished transformers and chokes of the usual commercial type are hardly available. Dynamo sheet iron in plates is available, although it usually arrives in poor condition because it is carelessly packed. They are rarely properly insulated by being lacquered or by having paper pasted on them. Cut iron cores seem to be available only from waste material. The cut sheet-iron croes (jacket type) always consist of individual strips, so-called E-cores (three legs and one yoke made of one piece, the second yoke separate) are rare, so-called tongue cores (three legs and both yokes of one piece, the inner leg provided with a notch at one end) are unknown.

The commercial transformers are correctly dimensioned magnetically, but usually dimensioned too small electrically, so that the windings heat up considerably even under normal load, while the transformers cannot take much excess voltage), The cores and windings are protected against moisture only with bitumen, if at all, while lacquer coatings are unknown. Transformers and chokes seldom come with cast frames, or with finished terminal strips of either primitive or better form.

The cut sheets are marked by their uneven dimensions, since they are obviously cut by plain automatic metal shears and not by punches, the edges are

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always jagged and not cleanly cut and never smoothed out.

j) LF and IF transformers and ~~chokes~~ chokes: The statements made above also apply here. Better sheet-iron alloys and thinner sheets than the usual dynamo sheets are not available.

k) HF iron cores: Iron cores with molecularly distributed iron, in the form of threaded inserts, are available in sufficient quantity. Their electrical values render them suitable for use in the standard broadcast and long-wave ranges. Special short-wave and ultrashort-wave cores, or any form but threaded inserts are unknown.

l) HF litz wire

HF litz wire for laboratory use was not available. The laboratory worker has to make them himself from lacquered or silk-covered copper wires. The coils of radio receivers are usually wound with solid wire.

m) Insulation material of paper or textile and synthetic resin: Plates, rods and tubes are available in limited quantity. Especially in the case of the rods, the surface is very poor. The plates are usually uneven and have a disproportionally large, wedge-shaped edge. The tubes all have oval cross-sections.

n) Rolled brass: Brass strips and tubes (up to 15 mm external diameter) are available in sufficient quantity and in very good quality, with flawless surfaces. They are excellently suitable for bending and for soft-soldering. The brass sheets with a thickness above 0.5 mm are very poor, with scaly surface and layers of scale enclosed. They always arrive in poor condition, because of the bad packing. They are not very suitable for soft-soldering, because they are improperly alloyed.

Brass tubing of greater dimensions (between 20 and 200 mm diameter, of the type suited for decimeter wave guides and cavity resonators) have inferior surfaces, making difficult mechanical reconditioning necessary. Their lack of suitability for soft-soldering is especially striking, because some of the alloys supplied resemble bronze. They are extremely difficult to obtain.

Other rolled profiles, such as U- or T-angles, are not known.

o)

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o) Wire resistors : Wire resistors, wound on porcelain tubes or ceramics, are known. Resistors in the form of wires or ribbons, of various alloys and all dimensions, are amply available. They are all of excellent quality. Finished resistors are difficult to obtain. They must usually be assembled by the user.

The production of high-load resistors by the applying of a protective enamel coating is unknown.

p) Wire-wound rheostats and potentiometers: High-ohmic, low-load (up to 5 W) models are difficult to obtain. Their design characteristics are poor. Only those with arithmetic characteristics are manufactured.

Low-ohmic (up to 20 ohm) items for high loads, usually wound on asbestos, are well designed and available.

q) Carbon resistors: A 2 W type (similar to the "Karbowid 4a" made by Siemens, and obviously a copy of it) is available, although it has no protective lacquer coating, ~~xxx~~ and its terminals are not tin-plated but consist of brass with poor soldering quality. High-ohmic and low-ohmic types are amply available, but none of them are low-load types. The low-load types are copies of American models, ~~but very limited in quantity~~. The resistance specifications are completely unreliable. Low-induction HF and UHF models are unknown.

r) Carbon potentiometers: High-ohmic and low-ohmic types with loads ~~xxxxx~~ of 1 W are available. Their dimensions are large and the design is poor. The only type of contact known is the slide contact, Swash plate contacts and mercury contacts are unknown. Only potentiometers with arithmetic characteristics are known, those with logarithmic and other characteristics are probably not available.

s) Circuiting: Wiring of equipments is usually haphazardly arranged. Even where coupling capacitances and circuit inductances are unimportant, such as in large supply lines and in insensitive circuits, neat and rectangularly arranged wiring is generally not carried out.

Ample supplies of soldering tin (usually pure tin) are available for soft soldering. Solid Colophony and acqueous zinc chloride solution are used as flux. The latter is used with no regard for corrosion effects. Organic soldering flux or soldering pastes are not used. Special tools, such as long-jawed pliars or tweezers,

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or tools for removing lacquer, are lacking. Electric soldering irons must be made by the worker himself.

The method of using spot welding for wiring is not known.

Hard soldering (especially of assembly elements) is a touchy problem. Not only is the knowledge of the field of hard soldering very limited, but suitable soldering alloys are hardly ever available. Usually any kind of brass which happens to be around is used as solder. The results are usually disastrous. Either the assembly part itself has melted or the joint does not hold. For that reason, hard soldering is avoided as much as possible. Soldering of aluminum or aluminum alloys was not observed, nor did I see any equipment on which such a process had been carried out.

Electric welding is preferred to acetylene welding (most likely because of the constant trouble of obtaining oxygen and acetylene on time). However, both are carried out with unbelievable ignorance and carelessness. The same as for soldering applies to electric welding. Regular industrially-produced electrodes are not available, and any steel wire within reach is used instead, after it has been cut into pieces, dipped in lime and dried.

Q. 18: What German communications equipment was repaired and which types are now being used by the Red Army?

A: a) The Institute had a captured airborne panorama set of type "Rotterdam". All electrical and design data, and testing and assembly instructions were also on hand. The set was complete, except for a few minor details in the power supply system. It was to be repaired and put into operation. However, the Russians managed to "repair it to death", and, after a few months, lost interest in the device. This occurred at the time when the Russians had more captured material than they knew what to do with. Later on, the set was cannibalized for screws, nuts, individual parts, etc. It is unlikely that the Russians will be able to reconstruct one of these sets on the basis of the data they have, unless they have other captured sets of this type, because the data originated from different stages of development and different modifications, and had become hopelessly mixed up. Even I, who was familiar with the set and who had even worked on these data at Siemens, had difficulty in making head or tail of them.

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b) The Russians also had many sets of type "Michael". These are decimeter wave directional communications sets with about 20 fixed transmitter frequencies and automatic receiver setting for 4(?) telephone channels and two teletypes with a mean transmitter frequency of 54 to 56 cm. About twenty of these sets were repaired and placed into operation. The roof of the Institute buildings had many of the antennas of these sets mounted on them, and it is assumed that the sets were in experimental service.

The Russians were greatly interested in this device. The available data were completed, as far as necessary, and worked out so that the set could be copied. I found out that the Russians were working on modifications, in order to find expedient solutions for bottlenecks in production and procurement of parts. I do not know whether or not these efforts were successful. The interest of the Russians in this device was so great, that one PW received the order to design a wind power plant, to be used as power supply for such stations to be set up in inaccessible regions. This wind power plant had a rated output of 500 W, corresponding to the power requirements of two sets per relay station, and was equipped with an emergency battery for periods of calm.

The wind turbine itself was designed by Engr. Bozenhardt, while Engr. Filbert designed the electrical part. The Russians at that time intended to set up a large communications net with these sets or with the copies they had made from them. One of their main aims was to build the relay stations as crewless stations, while on the other hand, the impossibility - or rather the difficulty - of listening in was considered a novel and great advantage.

It is to be assumed that this project has been energetically pursued.

c) There were also two sets of the "Frankfurt" type. They are also directional decimeter communications sets, but operating on 20 cm waves and using a magnetron. This set, as far as I know, has more telephone and teletype channels. The sets were repaired and experimentally operated between the Institute and our workshop at Tarasowskaya. All necessary data for this set were available. After the experiments had been concluded, the sets were dismantled again. I do not know of any plans for their further use or copying.

d) I do not know anything about use of other communications equipment, espe-

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cially of the type used by the Army. An ultrashortwwave telephony set, developed at the end of the war in Germany, of the size of a tin can and with a steel ribbon antenna, with a range of about 3 km, was not taken serious by the Russians.

Q. 19: Exact description of Dr. Meinke's set, if possible with drawings.

Q. 20: Was this set copied, if so, when were practical tests carried out, and with what result?

A. to 19 and 20: Although I have already covered the main points of this question, I should like to recapitulate. The project of a directional decimeter communications set was developed during the war by a certain Dr. Meinke of Telefunken. After the war, the Russians ordered resumption of the project by the firm of Lorenz, Berlin, as we discovered from the drawings we saw. These drawings were of mechanical assembly parts which were to be built in our shop. The circuit diagrams and mechanical assembly drawings were not accessible to us. For this reason, and because of the confusion security methods employed by the Russians, it was impossible to get a clear over-all view of the device. As far as this was at all possible, it applied only to the transmitter part. Almost nothing at all became known about the receiver part. I assume that the receiver part was being worked on by a department which had no connection with the PW laboratory or was not permitted to contact us. In particular, nothing became known about the method used for the conversion of the received phase-displaced pulses into voice frequency. The Russians were strikingly and stubbornly silent on this point, despite repeated attempts at sounding them out. Thus, the data on the transmitter should be accepted only with reservations, since it represents only parts of a hazy pattern. The important data are as follows: Transmitter wavelength 20 cm. Continuous-dash output 100 W. Keying ratio 1: 10. Pulse sequence 10 ms. Pulse length 1 to 1,5 microseconds. Modulation by phase displacement of the pulses. 20 telephone channels (19 for normal conversation, one for servicing).

This set was to be used to establish a communications network, whose main advantage was to lie in the fact that any conversation could be removed from it at any point and replaced by another one. In otherm words, it was to be a regular telephone network, only using radio instead of cables. Each receiver station demodulates the received signal , separating all 20 channels, to voice frequency, whereupon the conversations to be removed can be picked out and others inserted. The newly formed signal then modulates the relay transmitter. Even at that time, the Russians were already speaking of a modification which would make it possible to demodulate only the desired message, so that the interference level in long-distance conversations picked up and retransmitted by many relay stations would remain low.

For the reasons already mentioned, it was impossible to determine how the version being developed by the Russians differed from Dr. Meinke's original and just what the modifications were. It is only certain that many modifications were suggested, dropped, and then modified again during the development stage.

It is difficult to say when this project reached the experimental stage. At any rate, after one year had passed, the laboratories were still busily working on it and the end was not in sight. Just then, the project caused a heated argument at the Institute, because the project had run way past all deadlines and because one difficulty after another (including shortage of materials) kept cropping up.

Q. 22: Was foreign research exploited, and if so, in what manner?

A: The evaluation of foreign research and development work (chiefly of American sources, some British ones, and very few French sources) is carried out with great care by special analysts. New books and technical and scientific periodicals are evaluated in an extensive bibliography each month, which contains the usual data on source, author, etc., and also a detailed report on the contents of the book or article.

Because of its large volume, special attention was given to captured German material.

I have no information on evaluations made by the Russian Intelligence Service. They were probably kept secret from German PW's. The above statement thus refers only to generally accessible material.

During my stay, a great project was under way to develop methods for copying the purchased British and American measuring and auxiliary devices by investigating their design, circuits, and other technical data. It is probably not unknown that this is common Russian practice.

The following episode occurred during that time: The Russians wanted me to develop a special oscilloscope for pulse oscilloscopy. The main problem would have been that of developing special broad-band measuring amplifiers, and the design of a time base generator with possibility of all kinds of combinations regarding synchronization and time base. I pointed out that this would mean a very long developing time, and that furthermore, the Americans probably already had such a device for a long time, and that it would be more economical to buy one from them. I said that because the project did not appeal to me for some reason. My guess, that an American device of this type was in existence, was confirmed, and I was also told that steps had already been taken for the purchase of a few models. However, the trouble was that the Americans were in no mood to sell just a few models, but wanted to sell a large number of them, if any at all. The Russians commented that the Americans were undoubtedly well aware of the Russian tactics of purchasing and then copying equipment and were therefore not interested in filling small orders.

I do not know how the matter of this purchase finally turned out. At any rate, the project was not assigned to the PW laboratory, since I pointed out the difficulties involved with the greatest emphasis. This occurred in the summer of 1947. The American oscilloscope in question is of type "Dumont B (number forgotten).

Q. 23: What kind of material is used for the experiments.

A. During my stay, such great quantities of American equipment and captured German material were available, that experiments were carried out almost exclusively with that equipment. German equipment was also frequently cannibalized for all kinds of parts.

It always struck me as peculiar that no attention was paid to the possibility of building copies when experimental sets were constructed, but that German parts were often used in critical places, when only a few items of these parts were available. That leads to the conclusion that there either was no corresponding Russian part in existence, or that the Russians expected to be able to copy the German parts without any difficulty.

As far as tubes are concerned, great stocks of American radio tubes and

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special tubes were available. With tubes, at any rate, great care was taken to employ only those types which were readily available. Therefore, ~~maix~~ mostly American tubes or their Russian copies were used.

However, a tube manual issued in 1947 (or 1948?) shows that the copying of German tubes, especially Army types, has been started on a large scale. These tubes have been given Russian type designations, but the Russians make no effort to conceal the fact that they are copies.

Q. 24. Historical data on the Institute.

A. The Institute was reportedly opened in the late 'thirties.

Q. 25: What is the proficiency of the Russian specialist engineers? Where, how, and how long are they trained? Are names of Russian experts known, who are instructors at Institutes of Technology or other Institutes? If so, where are they teaching?

A.: The main points were mentioned in my discussion of the two young graduate engineers in my labbratory. Whatever was said about them, applies to some extent also for the older engineers. The widespread use of empirical formulas rules, frequently without a solid physical basis, is notable. The definitions of physical and technical concepts are also frequently hazy. Some of this may be due to the confusion of German, English and Russian technical terms started by the Russians themselves. Even the department chiefs of the Institute were not above this habit. It is astounding occasionally to find out that someone with whom one has just carried on an intelligent conversation on pulse oscilloscopy turns out to know nothing about the phenomena taking place in a CR tube. In other words, even the high-ranking employees have no sound, over-all knowledge, but only a spotty knowledge. This seems to me to be a proof for the fact that a certain basis in general electrical engineering permits the comprehension and the treatment of any special subject removed from its context to a certain limited extent. This fact seems to be an essential part of the method by which the Russians are trying to reach the level achieved by foreign countries in the high-frequency field. The individual is assigned a field in which he has to work while he does not necessarily have any knowledge of the allied fields. This was probably caused by the necessity to work through voluminous captured material of technical nature in a short time

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and to absorb its contents.

It cannot be denied that the Russians have a large number of competent men and top experts. However, their work hangs in mid-air, because the technicians with sound and extensive knowledge, which they require to build their work on, are either missing altogether or not represented in sufficient numbers. Their level, as stated above, is very low.

Training: There is no differentiation between the degrees of "Ingenieur" and "Diplom-Ingenieur", as there is in Germany. The Russian graduate engineer, on the basis of his curriculum, corresponds to the German "Diplom-Ingenieur". After graduating from a secondary school, similar to the German high school, he immediately enters an Institute of Technology without first having to show any practical training as apprentice. He is supposed to work in a plant during the school vacations, but this work need not necessarily be manual. The course generally takes eight semesters. Then he takes his engineers' examination and gets his degree. In most cases he is immediately assigned to a job in the Northern or Eastern regions of the country. It takes special merit or a great deal of pull for a young graduate engineer to be assigned a job in the Moscow region. As far as I know, obtaining a doctor's degree immediately following the studies is not possible, but the candidate must prove several years of practical engineering experience before he is admitted. A doctor's dissertation must also be submitted for this degree, and I believe that the candidat must also take a special examination.

Since there is great lack of qualified engineers in all fields, a great deal of propaganda is made for correspondence courses. I have seen some of these correspondence students, and I must say that they will not prove an asset for Russian industry.

The above training course shows the reasons why Russian engineers are not sure of themselves once they get out of their special, restricted field. The Russians themselves seem to consider this a perfectly normal state of affairs. The following incident may serve as an example: On the basis of the many curriculi vitae which I had to write, and on the basis of the interrogations, the Russians were pretty well informed about my professional carreer, i.e.

high school graduate, three years of apprenticeship as precision mechanic, five semesters at an Institute of Technology, six years practice as engineer in laboratories and [illegible] designing offices of a large firm. That is the normal course of [illegible] training for a German engineer. On the basis of these data, the Russians looked down upon me a little, and in their files I was carried as a person whose training and knowledge would be equivalent to that of a Russian "technician". During my later activities, the Russians became suspicious of me, and did not conceal it, in the belief that I had not told them the truth about my qualifications. That had the reason in the fact that my knowledge was fully equivalent to that of the Russian engineers (all of them men with academic degrees and often with longer professional experience than I had) and also was founded on a much broader base. The Russians' suspicion of me was so great that it was recorded in my personal file, and that a special NKVD commission interrogated me prior to my repatriation in the fall of 1949 on whether I did not have a higher academic degree after all and whether I had not even been an officer. This should illustrate the level of the Russian engineers. It is also typical that the previously mentioned Major Saposhnikov was head and shoulders above the others. It should also be mentioned, that there is a special title of "Academician". The academicians are scientists of great merit who have been appointed members of a scientific society. Regular teachers of Institutes of technology and universities apparently always carry the title of Professor. They and similar personalities are practically under obligation to publish one or two research reports each year. The ideas of "Plan Fulfillment" or "Normal Fulfillment" and "Overfulfillment" also play and [illegible] important part in the purely intellectual professions. As everywhere else, the political authorities also have the last word here. Scientific research projects, development projects, etc., are all subject to strict deadlines which are set up by people not burdened with any knowledge of the subject.

Appendix:

Figure 1: Standard Loudspeaker for low-frequency wired radio networks

Kristall - crystal

Hartpappe - hard cardboard

hartes, dünnes Papier - hard, thin paper

Presspappe - pressed cardboard

äussere Abmessungen - outer dimensions

ohne Masstab - not drawn to scale.

Figure 2: Sketch of a metal -ceramics tube. This sketch corresponds approximately to a type with 200 W anode dissipation.

The tube is used for amplifier purposes. There is a special type available for use in oscillators, with a special design which increases the cathode- anode capacitance (so-called "crown coupling" /‾Kronenkupplung_7).

Handgriff - handle

Kuehlkoerper .... - cooling jacket of laminated cast aluminum

Kontaktflaeche fuer Anoden anschluss - contact area for anode connection

Anode, Kupfer/.. copper anode, slightly concave face

Keramikhuelse - ceramic jacket

Kontaktflaeche fuer Steuergitteranschluss - contact area for control grid connection

Steuergitter - control grid

Kathode - cathode

Heizer - heating filament

Kontaktflaeche fuer Kathode... - contact area for cathode and one end of heating filament

Pumpstutzen - pump sleeve

Kontaktflaeche fuer das andere... - Contact area for the other heating filament end

Anode - anode

Figure 3: Example of installation of metal - ceramics tube

Länge... - quarter wavelength minus effect of fixed capacitances

Einstellschieber... - adjustment slide for feedback

Rückkopplungsimpedanz - feedback impedance

Weg der Kühlluft - path of cooling air (blower)

Kondensator - condenser

Anodenanschluss - anode connection

Steuergitteranschluss - control grid connection

Kathoden- u. Heizanschluss - cathode and heating filament connection

Heizanschluss - heating filament connection

Fig. 4: Map of Institute grounds, scale 1 :30,000

Kriegsgef. Laboratorium, 1. Arbeitsstelle - PW laboratory, 1st site

vermutliche Lage... - probable location of rocket weapons plant

Nebengebäude ... - secondary Institute buildings, containing the decimeter wave departments

Hauptgebäude - main building

Auto- u. Pferdefuhrpark - Institute motor- and horse-drawn vehicle pool

Höhe 160 - elevation 160

Waggonfabrik - railroad car factory

Fluss - river

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Figure 5: Transmitter

19 Telefongesprāche - 19 Telephone messages

1 Dienstgespraech - 1 message for servicing

1-20 LF amplifier

21 -40 LF band filter

41 - electronic switbh

42 - integrator

43 - LF amplifier

44 - Carrier frequency oscillator

45 - convertor

46 - carrier frequency filter

47 - carrier frequency amplifier

48 - carrier frequency rectifier

49 - 1 kc oscillator

50 - Frequency divider

51 - phase displacer

52 - phase separator

53,54,55 - 10 kc amplifiers

56 - phase separator

57 - 10 kc amplifier

58 - 10 kc oscillator

59 - 10 kc amplifier

60 - reactive power tube

61 - Phase divider

62 - Phase displacer

63 - differentiator

64 - input amplifier

65 - output amplifier

66 - 10 kc amplifier

67 - time base generator

68 - Oscilloscope

69 - attenuator

70 - detector

71 - quartz oscillator

72 - tripling device

73 - doubling device

74 tripling device

75 - doubling device

76 - tripling device

77- doubling device

78 - output amplifier

79 - measuring antenna

80 - transmitter antenna

Explanations on next page.

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Explanations of Figure 5:

The terminals 1 to 19 can be supplied with 19 normal telephone messages. Terminal 20 carries either the servicing message or a measuring tone which can be heard after throwing switch S1.

The low-frequency amplifiers 1 to 20 are normal audio amplifiers and serve both as amplifiers and as separating stage. The 20 signals then go through the low-frequency band filters 21 to 40, where the band width of the signal is limited in both directions, especially to the upper limit.

A sinusoidal xxxxx curve is uniquely defined if three of the function values of each period are known. Thus a sinusoidal voltage is sent through a switch which is opened xxxxxxxx and closed with a frequency of 10 kc. Thus this switch can transmit a xx frequency of 10 kc equalling three times 3.33 kc without difficulty. All lower frequencies are thus over-determined, which does not do any harm.

The 20 low-frequency signals are combined by means of an electronic switch xxxxx 41 to a combined signal. This electronic switch contains, in its main principle, 20 xxxxx switch segments which are even distributed along a circle. The switch impulse is provided by a continuous electron beam rotating with a frequency of 10 kc. Thus each switch segment or each of the 20 telephone channels is scanned every ten-thousandth of a second. Behind the electron beam switch a signal with portions from all channels will thus be generated. This signal, according to the nature of its generation, consists only of individual points. In integrator 42 it is combined, or rather, supplemented to form a continuous voltage curve. This integrator is nothing but xxxxxx a broad-band LF filter which has high attenuation, especially for high frequencies in order to suppress the secondary frequencies which are generated during the switching process. The signal produced by the integrator now goes through the normal IF amplifier 43.

In order to be able to operate properly with this signal, its relative band width must be reduced. For this purpose, an AC voltage of approximately 100 kc is generated in the carrier-frequency oscillator 44. Converted 45 mixes signal and carrier frequencies and the product of this mixing process sent to carrier-frequency filter 46. The differential frequencies are eliminated there and only the summation frequencies are transmitted. The following process explains the purpose of the mixing, since the product of the mixing process is highly amplified in the carrier-frequency amplifier 47. If this is to be combined with high freedom from distortion, the detour via frequency transposition is necessary.

The subsequent carrier-frequency rectifier 48 contains a time constant for 100 kc, so that the LF signal is maintained.

The voltage obtained behind the rectifier serves for phase-modulation of the pulses. The 10 kc oscillator 58 which is controlled by a tuning fork supplies the basic frequency for the pulse generation, the cyclic deflection of the electron beam switch, the generation of the measuring signal, and the time base of the control oscilloscope.

Pulse generation and pulse modulation: The 10 kc amplifier 59 acts as an oscillator which is, in a manner of speaking, frequency-modulated by the reactive power tube 60 with the aid of the voltage obtained from rectifier 48. Since this oscillator is not independent, but is controlled by the 10 kc oscillator 58, the frequency modulation process effects only a phase modulation, so that the 10 kc AC voltage behind the amplifier 59 already contains the signal in the form of a phase displacement.

Phase divider 61 and phase displacer 62 permit the phase displacement of the signal by a constant amount in order to compensate for transit times within the apparatus.

Differentiator 63 differentiates the AC voltage by means of a choke. The pulses thus obtained are amplifier in the multi-stage input amplifier 64 and corrected, so that the pulses which now have the proper shape and width and their modulation content can be amplified to full power in the output amplifier 65. The power pulses obtained are used for controlling the antenna stage 78.

Due to the nature of the process, the entire set depends on the synchronization of the electron beam switches on the transmitting and receiving ends. Therefore the cyclic deflection of the electron beam deserves special attention. The deflection voltage is taken from oscillator 58 and goes through the 10 kc amplifier 57 which serves as separating stage. The phase divider 57 divides it into two voltages which are displaced in phase by 90°. These two voltages are then amplified in amplifiers 54 and 55 and supplied to the deflection coils of the electron beam switch. In order to synchronise transmitter and receiver, the servicing channel carries a 1 kc signal with constant phase, obtained from the 10 kc oscillator. The 10 kc voltage is again sent through a separating amplifier 53, then is supplied to the phase divider 52 and the phase displacer 51, again in order to accomplish phase compensation. The frequency divider 50 generates a voltage of 1 kc frequency, which serves for the synchronising of the 1 kc oscillator 49.

The high-frequency stage itself is based on xx a short-wave quartz crystal. This quartz which has relatively longer wave characteristics has probably been chosen simply because there was no other kind available. The quartz oscillator 71 is followed by the proper number of triplers and doublers 72 to 77, in alternating succession. The last stage, a doubling stage 77, serves as so-called "locking transmitter" ["Locksender"] for the final stage 78 which operates the antenna. The operation of this transmitter is as follows: An voltage or power source of the same frequency is placed in front of an independent oscillator. This will cause the exciting of oscillations with coherent phase, and also will reduce the build-up transient oscillations of the oscillator to a minimum. Especially the latter point is of great importance, since an oscillator is constantly excited by steep pulses.

Nothing detailed is known about the transmitter antenna 80, except that it probably is dipole in a parabolic reflector.

Finally, the control device should be discussed. It consists of an oscilloscope which allows observation of the pulses at the output of the pulse amplifier and of the radiated pulses.

In this case, again, a 10 kc voltage is taken from oscillator 58 and supplied to separating amplifier 66. The amplified voltage can be supplied to the oscilloscope 68 either directly, by means of switches S2 and S3, or it can be used for the synchronisation of a time-base device 67 (saw-tooth).

By means of switch S4, either the simple or the antenna pulse can be supplied. The simple pulse goes to the oscilloscope from the pulse output amplifier 65, over the attenuator 69, and is made visible in this form, either over a linear time base (saw-tooth) or over a sinusoidal voltage. For the radiated pulse, a low voltage is taken from the field of the transmitter antenna by means of the measuring antenna 79 and supplied to the oscilloscope over the decimeter rectifier 70.

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