In the Labor People's Name: Development of 60-kW Magnetrons in the Artificial Famine Plagued Ukraine in the Early 1930's

Alexander I. Nosich
Dept. Computational Electromagnetics
IRE NASU
Kharkov 61085, Ukraine
anosich@yahoo.com

Alexei A. Kostenko
Dept. Radio Introscopy
IRE NASU
Kharkov 61085, Ukraine
kostenko@ire.kharkov.ua

Abstract— **The emergence and formation of microwave, electronics and radar community in Ukraine had been closely tied to the invention and development of original high-power decimeter-wave split-anode magnetrons in Kharkov in the 1920-30's. Navigating their lives and research between the deadly Orwellian torrents of the early USSR, the scientists had to close their eyes on the politically motivated famine, which was devastating Ukrainian countryside. Both microwave research and development and food confiscations were done in the name of labor people.**

Keywords-early magnetron; Slutskin; Ukraine

I. Introduction

The history of magnetron development in the ex-USSR is poorly documented and generally not well-known in the West. Among several laboratories that took part in this development, important role was played by the laboratory located in Kharkov (a.k.a. Kharkiv), Ukraine. This paper is aimed at the proper positioning of the research into decimeter-band split-anode magnetrons with champion output power done there in the 1920-30s. Another aim is to remind the reader that this remarkable achievement was done in the never-met-before environment of severe totalitarian regime and actually used the funds accumulated by the government at the expense of starving to death millions of independent farmers in Ukraine.

II. Pre-history

It was late November 1911 when a young newcomer left the long-distance train at the Kharkov station and took a horse-cab to the city center. This was new lecturer in physics at the School of Physics and Mathematics of the Kharkov State (then, Imperial) University (KhSU). This university was already famous at the third, since 1804, in Russian Empire after Moscow and Kazan Universities, and the lecturer was quite happy to get his post there. He was Dmitry Rozhansky (1882-1936), who graduated from the elite St.-Petersburg University in 1904. His first small post was at the physics department of the St.-Petersburg Electro-Technical Institute headed by A. Popov, Russian pioneer of wireless telegraphy; however he spent the summers of 1905 and 1906 studying in Hettingen, Germany where his professor was N. T. Simon. After earning a Magister degree in St. Petersburg in 1911, he took a post of docent in KhSU where he was promoted to professor in 1912 [1]. From 1914 to 1921, i.e. all through the WWI, communist revolution, and civil war, he headed there the department of physics.

During 1917-1920, the power in Kharkov changed five times between the national Ukrainian forces, Lenin's Russian communists, German military, and Russian monarchists. The invasion of Ukraine via Kharkov in December of 1917 was, in fact, the first aggression of Lenin against a neighbor country. Still this was not as bad as in Kiev where the power changed hands 17 times until the retreating Polish Army blew up the bridges across the Dniper River in July 1920. Fortunately for the Ukrainians, Lenin opted for Ukraine as it was first claimed by the nationalist government when asking for autonomy in 1917: within the borders of the former imperial regions (guberniyas) whose population was predominantly Ukrainian. Then Kiev was considered politically unreliable and dangerously close to the Polish border. Therefore Kharkov's nearness to Moscow and strong communist cells among industrial workers suggested choosing it the capital of the Soviet Ukraine; the city kept this status till 1934.

After the Soviet regime was set in, the universities in Ukraine underwent multiple reorganizations directed at the radical elimination of potential dissidence and opposition. First of all, they were downsized and divided into smaller specialized schools. Professors were repeatedly scrutinized about their attitude to the new power and the line they had followed in the years of civil war. Funds for universities were scarce. All this led to sharp decline of research. No surprise that after a few years of such misery, many of a handful of professors who remained in three major university centers of Ukraine: Kiev, Kharkov and Odessa, left for Moscow as soon as the life there started improving [2]. However, the first half of the 1920's was a short time of relatively greater degree of freedom, both economically and politically, in what was eventually named "the USSR" in the end of 1922.

This work was partially sponsored by the IEEE via a Life Member Committee grant.

978-1-4244-5611-6/10/$26.00 ©2010 IEEE

Figure 1. Abram Slutskin, circa 1945

Being a “bread-basket” of the former empire, Ukraine was recovering from the war-time devastation sooner than other provinces. The science was then still a matter of random enthusiasts and Rozhansky was one of them. In 1921, one of two first research departments of physics in Ukraine was established at KhSU under his guidance.

However, after his family, which lived in a countryside house, was robbed by deserters Rozhansky eventually gave up [1] and accepted, in 1921, a research post at the prestigious new government Radio Laboratory in Nizhni Novgorod. Next year he moved back to St. Petersburg, then renamed as Leningrad, to the Central Radio Laboratory. From 1925 he worked at the Leningrad Institute of Physics and Technology (LIPT), where he initiated, in 1935, a special laboratory to explore the opportunities of detection of aircraft with the meter-band waves using the pulse method. In 1930, as frequently happened then, he spent several months in prison being interrogated in relation to the “Sabotage Case of Electric Industry”. His interrogators, as he told later to his friends and family, tried to extract from him a confession that “he was inventing a device able to distantly read the thoughts of Comrade Stalin” [1]. He was released without explanations and returned to his job. This event had apparently had no serious consequences, as in 1933 he was elected a corresponding member (junior fellow) of the USSR Academy of Sciences (AS). However it could definitely play back later if he did not die just before the Great Purge of 1937.

The Kharkov period of Rozhansky’s career as a scientist was devoted to the investigation of spark-gap oscillators, electric arc, oscillations in coupled circuits, rarefied gas discharges, etc. It looks like he had early gained a reputation of leader in the physics of electrical and magnetic phenomena. Moreover, he grouped around himself the likely thinking associates, supported a creative atmosphere in the department, and determined all major topics of research. Having a very wide circle of scientific interests, he was one of the firsts who foresaw the future of the high-frequency radio engineering and initiated research into generating the electromagnetic oscillations of high frequency.

Even after leaving Kharkov in 1921, Rozhansky continued consulting his former laboratory, through the visits done twice a year, and kept close contacts with his former staff and students. At that time he performed, both in Leningrad and in Kharkov, investigations into short electric waves generated by the cathode tubes after the methods developed initially by Barkgausen and Kurtz in Germany.

To his colleagues, Rozhansky was remembered as interesting and sociable person easy to get on with. He always behaved with a great respect toward a speaker, without a shade of authority of a reputed scientist. He was credited for encouragement of young researchers and promotion of careers of many of them. Here, it will be no mistake to say that the main discovery made by Rozhansky in Kharkov was not a physical effect however a person - Abram A. Slutskin (Fig. 1), his best student and the man who led, single-handedly, the research and development into magnetrons and radars in Ukraine from 1925 to 1950.

III. Ukrainian Magnetron Pioneers

Abram Slutskin (1891-1950) entered the school of physics and mathematics of KhSU in 1910, just before Rozhansky took his post there. One of innovations introduced by the young professor was a revival of the physics seminar with active participation of students. This seminar, according to Slutskin, determined his ever-lasting interest in electromagnetic waves. He graduated from the university in 1916 and worked there as assistant (till 1928), and then as professor of the physics department. In 1928, he was on training in Dresden, Germany where he visited laboratory of Barkgausen. In 1937, he was awarded the degree of D.Sc. (Soviet higher doctorate, earned through research) without defending a thesis. In 1939, he was elected a corresponding member and in 1948 academician (fellow) of the AS of Ukraine. His works had been focused on the development of magnetrons and pulsed radar [3]. He died of the heart attack waiting for a flight home after a mission to Moscow.

As known, A.W. Hull was the first to publish the idea of magnetron in the papers appeared in 1921 [4]. In fact, his magnetron was a low-frequency source, with electromagnet winding incorporated into the anode circuit and hence the oscillation circuit of the device. Soon after that, A. Zacek in Prague demonstrated (1924) a possibility of generating the high-frequency oscillations by introducing a resonance circuit between magnetron’s cathode and anode, and applying a permanent magnetic field of the strength close to its critical value [5]. E. Habann revealed (also in 1924) that, by splitting the anode into two equal segments (split anode) and placing a high-frequency circuit between them, one could drastically increase the output power [6]. In 1928-1929 in Japan, H. Yagi and K. Okabe also made a series of pioneering experimental works with a magnetron having a split anode in the form of two half-cylinders [7]. Today split-anode magnetrons can be considered as primitive versions of the cavity magnetrons famous since 1940.

ЖУРНАЛ
РУССКОГО
ФИЗИКО-ХИМИЧЕСКОГО ОБЩЕСТВА
ПРИ
Ленинградском Университете

ЧАСТЬ ФИЗИЧЕСКАЯ

Том LVIII
Вып. 2

ПОСВЯЩЕННЫЙ ПРОФ. О. Д. ХВОЛЬСОНУ ПО ПОВОДУ 50-ЛЕТИЯ ЕГО НАУЧНОЙ И ПРОФЕССОРСКОЙ ДЕЯТЕЛЬНОСТИ

ГЛАВНОЕ УПРАВЛЕНИЕ НАУЧНЫМИ УЧРЕЖДЕНИЯМИ (ГЛАВНАУКА)
ГОСУДАРСТВЕННОЕ ИЗДАТЕЛЬСТВО
1926

ПОЛУЧЕНИЕ КОЛЕБАНИЙ В КАТОДНЫХ ЛАМПАХ
ПРИ ПОМОЩИ МАГНИТНОГО ПОЛЯ.

§ 1. Введение.

Figure 2. Title page and first page of the 1926 paper on pre-magnetron.

It was in 1924 when Rozhansky, on a visit to Kharkov, suggested to Slutskin and D. Shteinberg (1892-1934) to study the behavior of standard vacuum electron tubes in external magnetic field. By using the triode tube R5 produced by a Leningrad electro-vacuum plant, they succeeded in generating electromagnetic oscillations with the wavelengths of 40 to 300 cm. This study was published in 1926 in [8] (see Fig. 2). Later they studied how the tube element geometry, operation modes, and magnetic field strength effected on these oscillations [9]. By their request, the Leningrad electro-communication industries had manufactured the diodes where anode was made from a non-magnetic material (tantalum). It is believed that in the end of 1925 Slutskin and Shteinberg obtained the oscillations with the wavelength of 7.3 cm as mentioned in the memorial paper about Slutskin [3], written by his former student I. Truten.

R&D into electronics in KhSU was substantially extended after a separate section of electromagnetic oscillations of the research department of physics was established there in 1926. Slutskin headed it from 1930 on. By that moment, Kharkov, the capital of Ukraine, became the third largest city in the USSR (before 1914, this place was competed for by Warsaw, the gates to Western Europe, and Odessa, the main port for grain export). This was the time when the Kharkov electronics community started developing rapidly, in addition to the earlier communities in Moscow and Leningrad. The government became more supportive to the universities than before, feeling a need for better management and technology, and also interested in defense research, being scared by an imaginary foreign intervention.

Thus, together with the other researchers better known in the West, Slutskin and Shteinberg can be considered as early pioneers of the magnetron sources. Through the 1920's, Slutskin actively engaged talented students and young scientists of the physics department into research, the major subject being the split-anode magnetron.

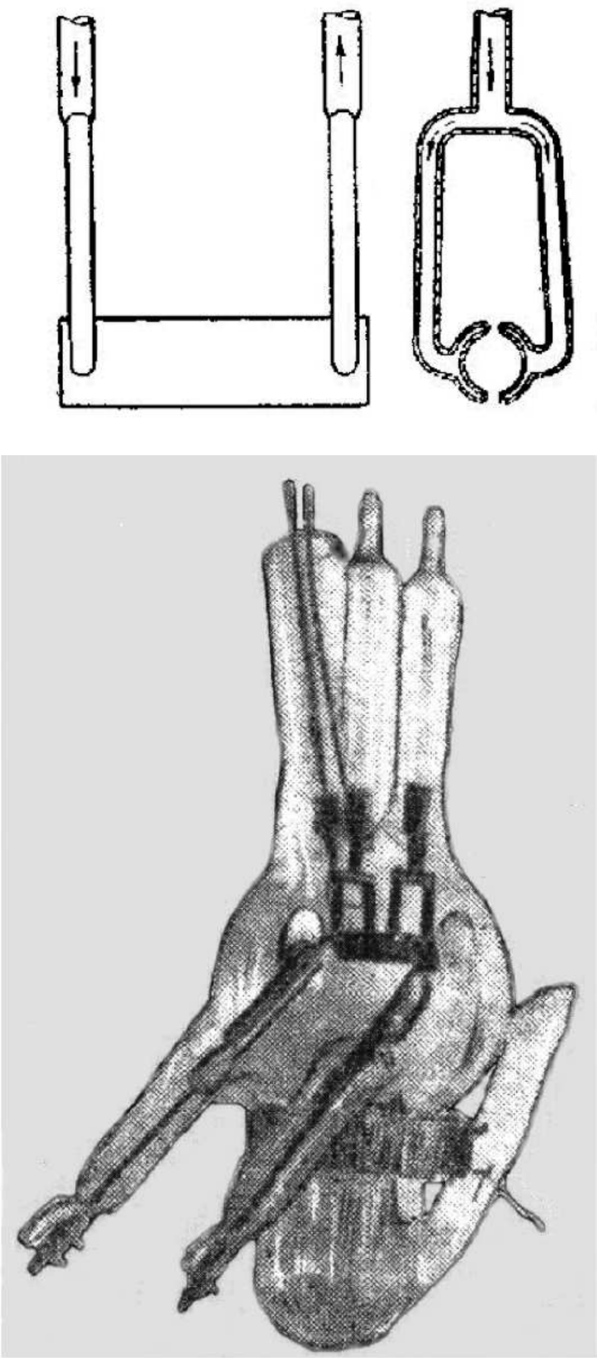
IV. UIPT AS A DREAM R&D CENTER

The next stage in magnetron research in Kharkov started with the foundation of the Ukrainian Institute of Physics and Technology (UIPT) in 1928. This brand-new R&D center had strongly influenced the progress in physics in the USSR and became a leader in several areas of advanced science including microwaves and electronics. The key role in organizing the institute was played by academician Abram Ioffe, who was then the director of LIPT founded by him in 1921. Among the colleagues, Ioffe was called by his nickname "Papa"; he had enjoyed extremely high reputation and influence in the highest Communist Party (CP) and government circles of the USSR until his death in 1950. Apparently, this effect had its roots in his total support of the policy of the CP; however a huge diplomatic talent was also necessary to navigate between the party fractions. It is known that "Papa" Ioffe persuaded the government that a decentralization of science was necessary and suggested that Kharkov, then the capital of Ukraine, was the best choice for a new major laboratory.

In sharp contrast to such a trust, in 1929-1931 the secret police then called GPU jailed over 100 scientists mainly from the USSR AS in the framework of the so-called "Case of the Academy of Sciences". The sentences those people got "for sabotage" may be looking soft if compared to the later practice of the Great Purge, and several most prominent of them, including the AS Secretary A. Oldenburg, geologist I. Fersman, and others were released without explanation. It is believed that the real reason for that "case" was the reluctance of the academicians to vote for the new members of Academy proposed by the CP and the government. In the first post-revolution elections in 1929, only a shameful one-vote majority elected N. Bukharin, a CP leader, while the other likely candidates were not elected. These results were immediately announced not valid, and in the second and the third tours all "Marxist" candidates were successfully elected academicians. This had apparently saved the Academy from GPU but started its shift from a club of distinguished scientists to a stiff bureaucratic body [10]. It should be added that "Papa" Ioffe was elected academician in 1929.

UIPT began its life in 1929 with a staff of 14 scientists including director, Ivan Obreimov, who had been working before in LIPT. Slutskin and Shteinberg were on this list still keeping their university posts in KhSU. In the beginning, the main scientific areas covered by UIPT were the solid-state physics and low-temperature physics, plus microwaves, and soon problems of nuclear physics were also added [11]. Early 1930's were the time when "bourgeois" middle class in the USSR was finally eliminated and replaced with Soviet "intelligentsia". The science was in the process of transformation from the hobby of enlightened liberal university professors to the centralized and tightly controlled state system. At that time, new laboratories were founded, which belonged neither to the universities nor to the USSR AS (still semi-independent and thus disliked by the CP and the government). Instead, these laboratories were incorporated into the powerful ministries, first of all the Ministry of Heavy Industry (NKTP), because of its weight.

Figure 3. Water-cooled magnetron in glass case, circa 1934.



Interestingly, NKTP had special Science and Technology Department headed by some of the better-educated CP leaders after they went out of Stalin's favor. Among them, one could see N. Bukharin, G. Krzhizhanovsky, A. Rykov, M. Tomsky, who were jailed and shot in the later years.

UIPT, as well as LIPT, belonged to NKTP until the dissolution of this ministry in 1939. It was May 1930 when the main group of the Leningrad scientists from LIPT came to Kharkov. These scientists, the most prominent of them future Nobel Prize winner Lev Landau (1908-1968), were of a younger generation, brought up in the Soviet style and attracted by the promising research and career opportunities as well as by the offer of better salaries and service apartments. Engagement of high-qualified experts, impressive funds rendered by NKTP for purchasing equipment abroad, together with rapid building of the laboratory and living blocks helped shortening the start-up period. Official opening ceremony took place on November 7, 1930, and the first fundamental experiments were conducted as soon as in 1932.

V. LEMO Projects and People

The Laboratory of Electromagnetic Oscillations (LEMO) was established as a department of UIPT as early as in 1930, led by Slutskin. This was the only one department headed by a Kharkov scientist while the former LIPT staff headed the other eight. Besides, it was the only one engaged in applied science - electrical engineering and electromagnetic waves. We can easily guess that it was Rozhansky, working then in LIPT, who played important role in giving such a nice opportunity to Slutskin. In 1928 he accompanied Ioffe for a special meeting of LIPT scientists with Ukrainian government in Kharkov and until his death in 1936 he was one of the three official external consultants of UIPT. Within a couple of years, almost all the activities around magnetrons had moved from KhSU to UIPT. At the same time, Slutskin continued teaching in KhSU, which he considered as a pool for upbringing talented youth, the best of whom easily found positions in LEMO after graduation. During that period, he investigated the mechanisms and conditions of excitation of split-anode magnetrons and developed a theory of magnetron oscillator operating in the "dynatron" mode. This, together with the advanced technical equipment of UIPT, had enabled the scientists of LEMO to greatly extend the works on obtaining high-power oscillations.

By 1933, they had been intensively investigating all theoretical and experimental aspects of generating the electromagnetic oscillations of the decimeter and centimeter wavebands. A group consisting of Alexander Usikov, Petr Lelyakov, Yury Kopilovich, and N. Vyshinsky designed magnetrons with anodes split in two half-cylinders in the waveband of 20 to 80 cm with the CW output power of 30 to 100 W. Their results were published in 1934 [12,13]. These were the champion parameters at that time: CW output power of magnetron in watts was equal to the wavelength measured in centimeters. Later Semion Braude, Lelyakov and Ivan Truten had developed a water-cooled magnetron in a glass case that enabled them to achieve the output power of 5 to7 kW at the wavelength of 80 cm (Fig. 3).

Pavel Lelyakov, a leading expert of the laboratory who held a post of senior scientist, played important role in the research into raising the power and frequency of magnetron sources. Lelyakov is remembered as a talented engineer who made numerous important contributions to the development of magnetron sources. He seemed to maintain the same level of excellence in everything he put his hands to. In particular, it was Lelyakov who invented a magnetron with a hollow anode water-cooled from inside.

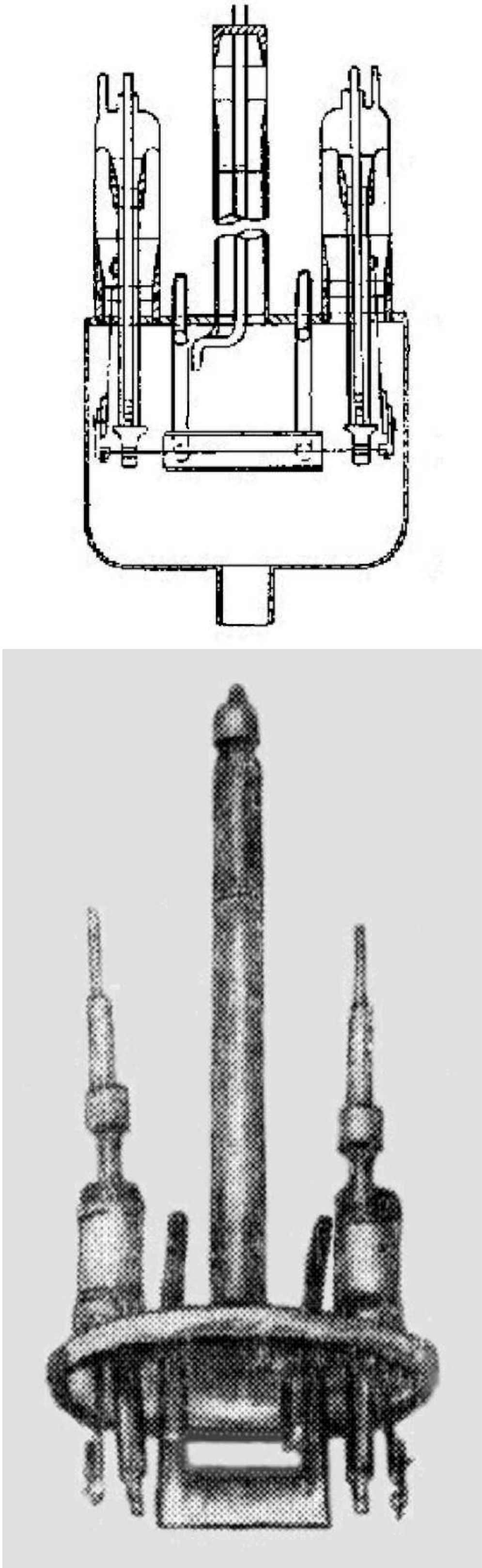


Figure 4. Water-cooled magnetron in metal case, circa 1934.

Two half-anodes were connected by tunable circuits consisting of metal tubes for bringing the water and carrying it away. This design served later as a basic one in various modifications

Braude achieved even a higher power level (up to 17 kW in CW mode) with 55% efficiency with an all-metal «barrel-type» oscillator. Besides, a sample tunable magnetron was designed, in which the frequency was tuned by 30% by varying the length of the circuit extended off the metal case. These results were published only in 1946 [14]. In 1941, however, Lelyakov stayed in Kharkov occupied by the Nazis although Slutskin tried, in vain, to ensure his evacuation, and left for Germany in 1942. It should be noted that this was not a surprise for his colleagues in LEMO because he had criticized the CP policy already before the war.

At the same time, an extensive investigation of the magnetron power and frequency control and design of a pulse-mode device was carried out, led by Usikov. In 1933, he discovered the effect of discontinuous modulation, which could be observed in a magnetron provided that its connection circuit corresponded to the relaxation scheme. Later he and also Lelyakov and Vyshinsky [15] were investigating the characteristic features of the magnetron pulse excitation. In the course of research, some promising new properties of this source were found. The most interesting effect was a discontinuous generation mode of the magnetron. This unexpected discovery had become a very important event in the laboratory. The progress in generating high-power electromagnetic oscillations drew attention of the government, which decided the high-power magnetrons should be important for the military. Therefore the Technical Department of Red Army charged UIPT with manufacturing a party of pulsed magnetrons for the needs of its own laboratories.

Around the institute, however, the life was developing along absolutely different rules. In 1931-1933, genocide-scale famine devastated Ukraine when the CP government decided to eliminate the grain market. Then GPU was ordered to confiscate, if the grain tax could not be paid off, all other foods from the farmers. As, besides of Ukraine, such killing measures were introduced only in the North Caucasus and a part of Volga region inhabited by the ethnic Germans, this artificial famine is believed to be the political action of Russian communists, with a smell of ethnic cleansing. Today the most conservative estimations place the number of victims in Ukraine close to 4 million. The end of this cruel campaign saw independent farmers eliminated and the USSR being the largest grain seller in the world market. The obtained funds enabled the government to buy sophisticated machinery, tools, and equipment in the West, shaken by the global economic crisis, build factories and power stations, and feed the military. In a way the UIPT scientists were also fed and their labs equipped at the expense of the starved to death peasants whose bodies were collected in hundreds every morning along the Kharkov rim by the police patrols. However, very few people knew about the real scale of famine as any reference to it in the news was strictly prohibited.

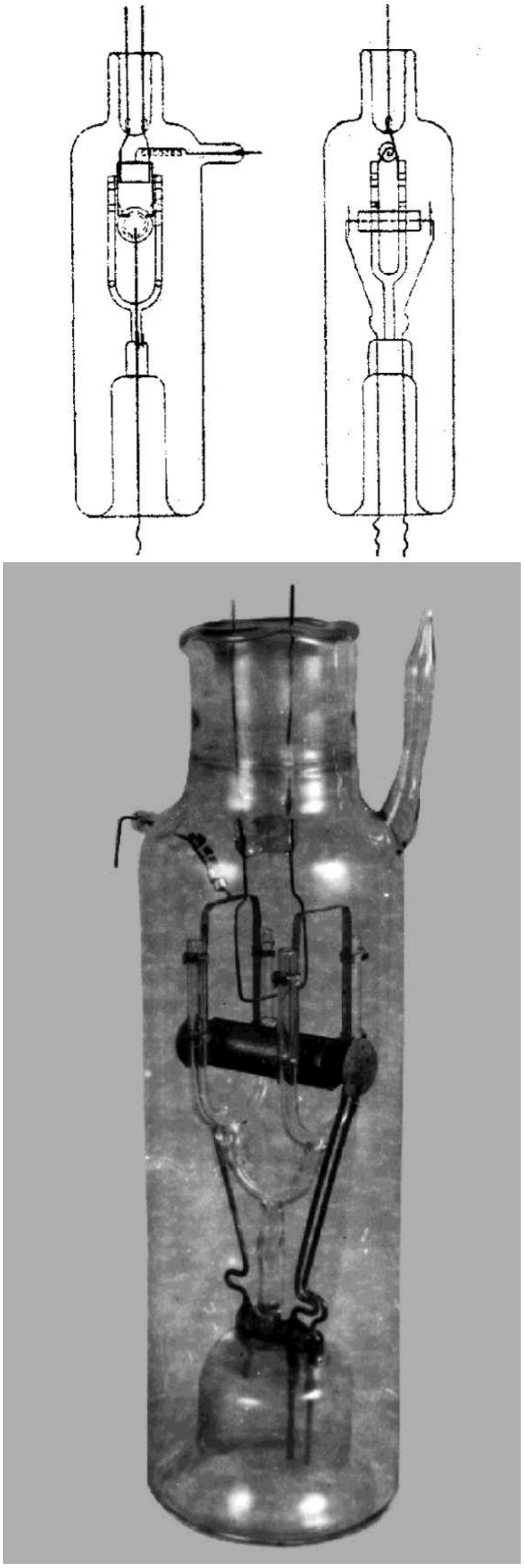


Figure 5. Non-cooled 60-kW magnetrom for 60 cm wavelength, 1935.

The other investigations funded by the Red Army in the first half of the 1930's included testing of the various operational modes of Slutskin's magnetron that could provide a maximum pulse power together with frequency stability. At that time, a packaged noncooled magnetron with a linear cathode inserted in a glass case was developed (see Fig. 5). It achieved the pulse power of 60 kW at the wavelength of 60 to 65 cm. Besides of Slutskin, two former KhSU students of him, Usikov and Braude, were principal developers of magnetrons.

Alexander Usikov (1904-1995) graduated from the physics department of KhSU in 1928 and started working in LEMO-UIPT in 1932. He earned his Ph.D. and D.Sc. degrees in 1936 and 1964, in physics. In 1958, he was elected a corresponding member and, in 1964, academician of NASU. From 1945, he headed a laboratory and in 1950-1953 the radio-physics department of UIPT. From 1953 he also served as a vice-director of UIPT in science. After the establishment of new Institute of Radio-Physics and Electronics (now IRE NASU), which branched off UIPT in 1955, his career continued there: director (1955-1973), head of department (till 1987), administration adviser (till 1992), and eventually honorary life director. He was awarded a title of the Honored Scientist of Ukraine, and was Lenin Prize (1960) and Ukrainian National Prize winner (1981). Since 1995, IRE is named after A.Y. Usikov.

Semion Braude (1911-2003) graduated from the physics department of KhSU in 1932. Being a student, he got involved in scientific work in UIPT, where he worked in LEMO since 1933. He obtained his Ph.D. degree in 1937, D.Sc. degree in 1943, and professor title in 1944. In 1958, he was elected a corresponding member, and in 1969 academician of NASU. From 1943, he headed a laboratory in the radio-physics department, and from 1947, a department of wave propagation at UIPT. In 1955-1980, he was a vice-director of IRE. After branching of the Institute of Radio-Astronomy off IRE, in 1985, he became an administration adviser there. He was a Stalin Prize (1952) and Ukrainian National Prize winner (1997), and was awarded a title of the honored scientist of Ukraine and A. Popov's gold medal of the USSR AS. In the Kharkov R&D community, the following saying of Braude had been famous: "I cannot be a director of an academic institute for two fundamental reasons – I am not a CP member and I am a Jew."

Two other important members of the magnetron team were Truten and Vigdorchik. Ivan Truten (1909-1990) started his scientific activity in UIPT in 1932 being still a student of KhPI. Having graduated in 1935, he enrolled a Ph.D. course of Slutskin (he defended his thesis in 1942 in Bukhara). After the establishment of IRE NASU, he headed there the department of pulsed sources, until 1969. He became a Lenin Prize winner in 1960. Truten was famous as extremely modest person. Once he declined a proposition to be awarded a D.Sc. degree without a public defense, thanks to his perfectly high expertise. He retired as soon as he reached the age of 60 that was very unusual both in the 1960's and in other times.

Iosif Vigdorchik (1910-1980) graduated from the school of physics and mathematics of KhSU in 1932 and started working in UIPT. He obtained his Ph.D. degree in 1939 and worked in UIPT till 1953 when he was forced to quit because of the anti-Jewish campaign of the last days of Stalin. In 1952-1963 he taught at several universities in Kharkov. He came back to IRE in 1963 and held a position of the head of laboratory in the department of pulsed sources until 1979.

Simultaneously with improving the existed CW and pulsed sources, LEMO undertook a research into new devices and those having additional operation features. In particular, the feasibility of using a net as an electrode for controlling the output signal amplitude was demonstrated in 1935 in the Ph.D. thesis of Usikov. Later, Tkach designed a magnetron with a net able to generate the power ranging several tens of watts in the decimeter band; the results were presented in his Ph.D. thesis in 1940. These investigations were further continued by Braude and A. Ivanchenko, who designed an efficient magnetron with a net control, able to generate pulses of 5 to 20 μs and pulse power of several tens of kW [16]. These results were summarized in 1943 in the D.Sc. thesis of Braude.

One can judge about the scale of research carried out at LEMO-UIPT by the impressive number of papers published in the Soviet technical journals in the pre-war time, and by the number of successful Ph.D. presentations. Many of the results obtained during that period were of fundamental character and have not lost their importance till now. In particular, a research into higher-frequency magnetron sources resulted in the discovery, done in 1945 by Truten, of a special type of the cavity magnetron operation. It consisted in interaction of the electron flows not with the fundamental space harmonic of the microwave field but with one of the delayed higher-order harmonics. These working modes were later called the "Kharkov-type magnetron operation modes", in Soviet literature. They enabled one to reduce considerably the static magnetic field magnitude and the manufacturing tolerances of the anode resonator. As a result, a series of the millimeter-band magnetrons were produced having a champion power (e.g., pulse power of 100 kW at the wavelength of 4 mm achieved in 1960). Another example was a method of magnetron modulation with the aid of electrostatic lenses, proposed by Usikov in 1936. In the 1970's, it served him as a basis for designing the surface-wave magnetrons with the lens optics, together with G. Levin.

VI. Conclusions

Thus, by the end of 1936, LEMO-UIPT had carried out a wide-range fundamental research on the magnetron generation method and had a complete set of the 60-cm (L-band) devices both for CW and pulse operation. This was a solid background for launching a complex work on developing pulsed radar – "radio-searchlight", as it was called by Slutskin when he conceived the idea in 1935 [17]. By that moment, several laboratories in the USSR were working towards the design of radar. However, only LEMO happened to possess the both of two crucial ingredients – high-power source of short enough waves and experience with pulse method. The key point was the pulsed mode of operation of their decimeter-wave magnetrons – this seems to be the exclusive know-how of LEMO in 1936, without any close competitors in the USSR or elsewhere. However such radar was not developed by the start of the Hitler's offensive on the USSR. The reasons were not in poor engineering. Starting from 1935, UIPT found itself under wave after wave of investigations of NKVD. As explained in [11], their main target was Landau and foreign scientists; however the work of LEMO was also spoiled.

Acknowledgment

The authors thank the CAVMAG 2010 Organizing Committee for the encouragement and support of participation in the conference.

References

[1] I.D. Rozhansky, M.M. Rozhanskaya, S.R. Filonovich, Dmitry A. Rozhansky, Moscow: Nauka Publ., 2003 (in Russian).

[2] Y.A. Khramov, History of Formation and Development of Physical Schools in Ukraine, Kiev: Feniks, 1991 (in Russian).

[3] V.K. Tkach, "Abram A. Slutskin," Proc. Physics Dept. of School of Physics and Mathematics of KhSU, no 4, pp. 17-22, 1953 (in Russian).

[4] A.W. Hull, "The magnetron," AIEE J., vol. 49, no 9, pp. 715-723, 1921.

[5] A. Zachek, "Uber eine methode zur erzeugung von sehr kurzen elektromagnetschen wellen," Casopis pro Pest. Math. a Fyz., Prague, vol. 53, p. 378, 1924.

[6] E. Habann, "Eine neue generatore," Zeitshrift fur Hochfrequentztechnik, vol. 24, pp. 115-120, 1924.

[7] K. Okabe, "On the short-wave limit of magnetron oscillations," Proc. IRE, vol. 17, no 4, pp. 652-659, 1929.

[8] A.A. Slutskin, D.S. Shteinberg, "Obtaining the oscillations in cathode tubes with the aid of magnetic field," J. Russian Physico-Chemical Soc., vol. 58, no 2, pp. 395-407, 1926 (in Russian).

[9] A.A. Slutskin, D.S. Shteinberg, "Electronic oscillations in two-electrode tubes," Ukrainian Physics Notes, vol. 1, pp. 22-27, 1927 (in Ukrainian).

[10] N.I. Kuznetsova, "Tough experience of history: lessons of "sovetization" of science and university education," Digest of the Russian Academy of Sciences, vol. 74, no 2, pp. 160-166, 2004 (in Russian).

[11] Y.V. Pavlenko, Y.N. Ranyuk, Y.A. Khramov, The Case of UIPT, Kiev: Feniks, 1998 (in Russian).

[12] A.A. Slutzkin, P.P. Leljakow, E.A. Kopilowitsch, I.A. Wyschinsky, A.J. Usikow, "Faktoren welchedie leistung und den wirkungsgrad von magnetronschwingungen beeinflussen," Physicalische Zeitschrift der Sowjetunion, vol. 5, no 6, pp. 887-901, 1934.

[13] A.A. Slutzkin, P.P. Leljakow, E.A. Kopilowitsch, I.A. Wyschinsky, A.J. Usikow, "Erzeugung von elektromagnetischen wellen kurzer als 50 cm mit schlitzanodenmagnetronen," *Physicalische Zeitschrift der Sowjetunion*, vol. 6, no 1-2, pp. 150-158, 1934.

[14] A.A. Slutskin, S.Y. Braude, I.D. Truten, "Obtaining high-power oscillations of the decimeter band with the aid of continuous-wave magnetrons," Radiotekhnik*a*, vol. 1, no 9, pp. 12-17, 1946 (in Russian).

[15] P.P. Leljakow, A.J. Usikow, I.A. Wyschinsky, "Intermittent oscillations in the split-anode magnetron," Physicalische Zeitschrift der Sowjetunion, vol. 10, no 2, pp. 266-268, 1936.

[16] S.Y. Braude, A.M. Ivanchenko, "A magnetron with a net control and its applications in medium, ultra-short, and decimeter waves," J. Technical Physics, vol. 14, no 10-11, pp. 611-622, 1944 (in Russian).

[17] A.A. Kostenko, A.I. Nosich, I.A. Tishchenko, "Development of the first Soviet three-coordinate pulsed radar in Kharkov before WW II," IEEE Antennas Propagation Magazine, vol. 44, no 3, pp. 28-49, 2001.