RUSSIAN ELECTRONICS CHRONOLOGY

Ludmila I. Sharygina

Professor of the Radio Electronics and Information Security Department
Tomsk State University of Control Systems and Radio Electronics
Tomsk, Siberia, Russian Federation

Published by TUCSR, Tomsk, Russia, 2010

L.I. Sharygina, *Russian Electronics Chronology*, TUCSR Publishing House, Tomsk, Russia, 2010.

Chronology of the events connected with the history of electronics development in Russia is given in the book. While choosing the facts, the main attention was paid to the role of personalities.

At the end of the book there are given chronological data concerning some enterprises of electronics profile in Russia. These data provide the general impression about the level of the electronics industry development in Russia in the second part of the XX century.

The list of sources of information at the end of the book can provide additional information concerning the subject.

Edited by G. Sharygin

ISBN 978-5-86889-532-6

CONTENTS

FROM ANCIENT TIMES UP TO NOW

Interest to the world knowledge, its description and ways of information interchange started being formed in the extreme antiquity. Drums, megaphones, whistles and other smart devices were used for signaling during the epoch of paleolith. The siren (the device generating sound by quickly rotating subjects) has been invented. Consecutive relaying of light signals along vast distances was a prototype of modern radio relay.

Four-five thousand years ago the written language was invented and two thousand years ago the alphabet came to life. The Ancient Greek civilization has given to the world the whole galaxy of outstanding scientists and thinkers. In II-VI centuries BC dependence between the period of a string vibration and its length has been found out, ideas of harmonious movement (Pythagoras) were pronounced, Thales of Miletus started studying the electric and magnetic phenomena. There were formed ideas about atoms (Democrit, Epicur), about the sound nature and its reflection from obstacles (Aristotle). The various optical phenomena have been described by Empedocles, Aristotle, Euclid, Ptolemy. There was a library in Alexandria consisting of 700 000 papyrus rolls.

With the approach of a new era the interest to the world knowledge remains. Universities were organized and they became the centers of scientific research. New devices were invented to speed the research – microscope, “calculator”, “printing” device.

Research in the fields of electricity and magnetism, of sound propagation and mathematics were going on. The considerable attention was given to the philosophy as to a science that could provide understanding of the purpose of knowledge as the ability to increase the power of the man over the nature and also understanding that the science could help to solve the problems by processing the results of experience. From this point of view we can consider the R. Cartesian's book «Reasoning on a method», where the main principles of

scientific methodology of fundamental and applied research had been formulated as well as the difference between a person and a thinking machine.

The first transmission media of information were formed – the legalized complex of signals for alarm systems using flags, the optical telegraph, signal codes for ships and so on.

Benjamin Franklin
1706-1790

Alessandro Volta
1745-1827

Luigi Galvani
1737-1798

Charles de Coulomb
1736-1805

Pieter van Musschenbroek
1692-1761

Outstanding scientists and inventors of a XVIII-th century

The first serious research in the field of electricity started in the XVIII-th century. This century provided the first glass electric device, the phenomenon of electric conductivity has been opened, the electric capacitor («Leiden jar») and the lightning conductor were invented. S. Coulomb and L. Galvani were the leaders of research. There were the first signs of interest to studying the electric phenomena of biological objects. Electric and electromechanical means of the

alarm systems and information transfer were developed. The idea of electrostatic telegraph has been formulated.

Alessandro Volta's invention of a direct current electrochemical source in 1800 opened a new way for research.

The XIXth century became a century of industrial revolution, the time of a steam-engine, phone and radio birth.

Andre-Marie Ampere
1775-1836

Michael Faraday
1791-1867

James Clerk Maxwell
1831-1879

Georg Simon Ohm
1787-1854

The well-known scientists of a XIX-th century

There was opened thermal, chemical, light and magnetic action of the electric current, a number of the important physical phenomena was found out and studied: such as decomposition of water by an electric current, an electric arc, chemical action of a current, an internal photo effect in selenium, unilateral electrical conduction of semiconductors.

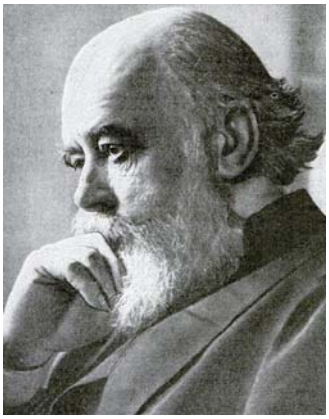
Detection of the electromagnetic induction phenomenon and oscillatory character of the spark was a feature of the XIXth century, as well as the effect of cathode rays and the ability of cathode beams to deviate under the influence of a magnetic field.

The law of the electromagnetic induction and the laws of electric current flow in circuits had been opened, the theory of an electromagnetic field was created, existence of the electromagnetic field was proved, the first devices of radiation and reception of electromagnetic waves were built.

There were invented the electrostatic and electromagnetic telegraphs, the telephone, the typewriter and the analytical computing machine with a memory, the lead accumulator, the electric lamp , the phonograph and "telephotographer", the record player, the first calculator, the coherer and the oscillographic tube for the observation of the fast electromagnetic phenomena.

By the end of the XIXth century all the necessary preconditions for the radio invention – the most remarkable invention in the mankind contemporary history – have been created. And it has appeared – almost simultaneously and in several countries.

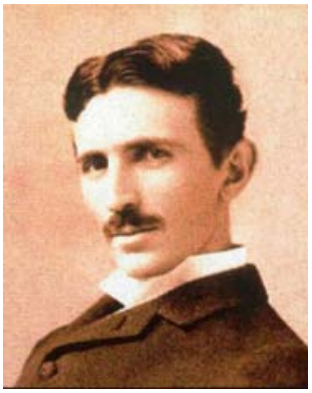
Heinrich Hertz
1857-1894
(Germany)



Oliver Lodge
1851-1940
(Great Britain)

Alexander Popov
1859-1906
(Russia)

Guglielmo Marconi
1874-1937
(Italy)



Nikola Tesla
1856-1943
(USA)

Inventors of radio

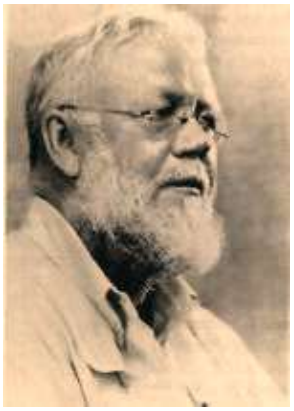
The first half of the XXth century was the time of great inventions in the field of radio electronics, which followed one another: the vacuum diode, the

electronic lamp and reception television tubes, and on the verge of the fiftieth years – semi-conductor devices.

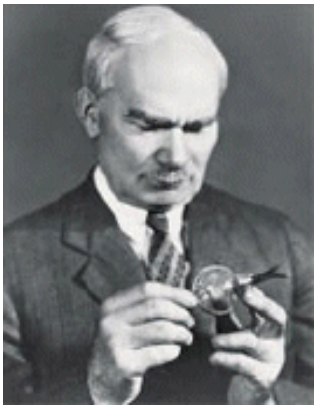
John Fleming
1849-1945

Vladimir Zvorykin with his iconoscope
1880-1982

Edvin Armstrong
1890-1954



Reginald Fessenden
1866-1932



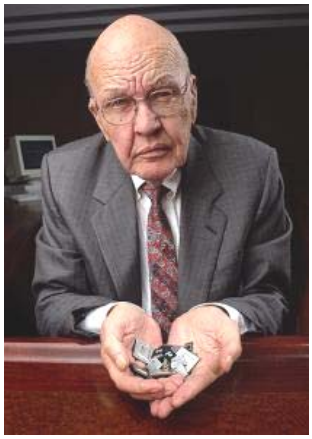
Lee ðe Forest
1873-1961

Nikolay Papaleksi
1880-1947

Outstanding scientists of first half of XX-th century

Radio found more and more various applications – communication, broadcasting, television, radar-location and radio navigation. There were invented various kinds of modulation, first of all, amplitude and frequency modulation. There were built the first electronic programmed computers. It seemed that electronics can manage everything.

If first half of the XXth century was the time of inventions, while the second half became the time of technologies.



«The father of microcircuits»
Dzhek Kilbi

Physicist-theorist
Vladimir Fok

The *Soviet radio physicist*
Boris Vvedensky

What was invented, found practical application and became stimulus of the further development at unprecedented rates. Radio and television came to nearly every house, mobile phones became ordinary things, the computers first occupying huge premises became small, and their potential became immeasurably large. Transistors and microcircuits made the equipment more compact and multipurpose that promoted their popularity.

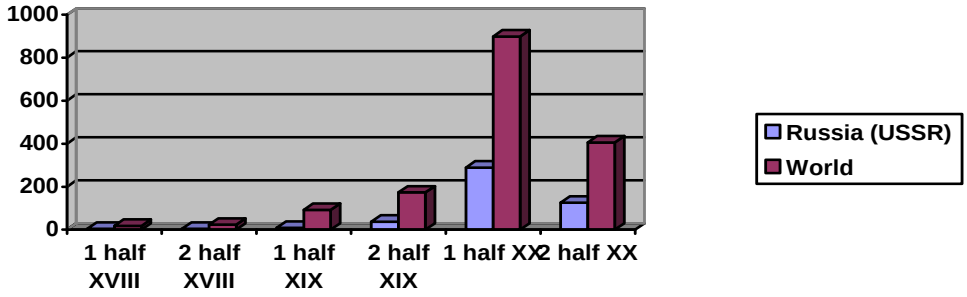
SCIENCE AND ENGINEERING IN RUSSIA

Development of techniques and the exact sciences in Russia is connected, first of all, with the name of the Russian emperor Peter the Great – the great reformer and the builder of the great empire. Deprived of the feeling of false patriotism, Peter the Great tried to adopt and transfer to the Russian soil the European experience and achievements in various areas of sciences and technologies.

Foundation of the first university and Academy of Sciences, building of the advanced for those times military fleet, strengthening of the Russian statehood, industry and trade, reform of the education system are connected with his name. Peter the Great progressive undertakings have been continued by the majority of the subsequent Russian emperors, first of all by Catherine II.

During next generations combination of the European experience and the Russian character provided positive results, promoted in Russia scientists and engineers of the world level, gave fast growth of industry and, in particular, development of such its advanced branches, as radio engineering and electronics.

The picture shows the scientific and technical achievements of Russia in comparison with the similar growth all over the world.



In the XXth century the Russian people had to endure great shocks. The Revolution of 1917, the First and the Second world wars, reprisals of 30th, disintegration of the USSR in the 90th of the century have left the mark on the

science development in Russia. The first and the second waves of emigration have deprived Russia of many remarkable scientists and engineers. It is enough to mention the names of D. Sarnov, V. Zvorykin, S. Ajzenshtejn and others. Many outstanding experts were lost in days of reprisals and the Great Patriotic War. In the second wave of emigration from Russia in the nineties 110 thousand people left the country annually, 20 thousand of them - to the USA.

Still the military requirements, the “cold war” and the planned economy promoted concentration of efforts of scientists and engineers on the decision of many scientific and technical problems. Traditionally high level of Russian education in the second half of XXth century helped a lot. Achievements in the field of nuclear technologies, the space research and radio electronics were the results of this development.

RUSSIAN ELECTRONICS CHRONOLOGY

All scientists and engineers mentioned further were the Russian citizens or constantly worked in Russia (the USSR), the mentioned events also took place in Russia if it is not specified differently.

1699

- Introduction of the system of signal communication in Russia – Peter the Great.

1724

- "Academy of Sciences" foundation according to the project of Peter the Great adopted by the Senate.

1724

- Formulation of the code of signals in the "Russian sea charter".

1748

- M.V. Lomonosov formulated the idea that matter and motion can't be created or annihilated (the law of matter and motion mutual transformation).

1752

- M.V. Lomonosov together with Richman constructed «the thunderous apparatus» to extract the electricity from clouds. A high metal pole on the roof was the main part of the apparatus. The bottom of the pole was inside the building attached to the device reminding a modern electroscope. In 1753 professor Richman was killed by a fireball while doing experiment during a thunderstorm.

1756

- Leonard Euler introduced the concept of potential into mechanics and found the remarkable property of this potential - called «the equation of Laplace».

1757

- Invention of electrophore – F. Aepinus.

1759

- Working out the first mathematical theory of the electric and magnetic phenomena – F. Aepinus.

1802

- V.V. Petrov opened the electric arc and carried out some experiments with it (fusion of metals, burning of various substances). Similar experiments were carried out in 1810 by G. Devy (England).

1803

- V.V. Petrov published a paper concerning “Galvani-Volta experiments”. He built the most powerful at that time battery with 2 100 Galvany elements, connected sequentially. He described the electric arc: “If one put two or three pieces of wood coal, able to provide light using Galvani-Volta liquid, on a glass plate or on a bench with glass legs and then move them as near to each other as (2.1–6.3) mm, using metal isolated guides, connected to two poles of a battery, the bright flame of white color would appear between the coals. This light can lighten a dark room”.

1819

- Foundation of the St. Petersburg University.

1832

- Demonstration of electromagnetic telegraph – P.L. Shilling.

1835

- E.H. Lents experimentally proved the reduction of resistance of metals being cooled.

1836

- B.S. Jakobi constructed one of the first electric motor of a direct current – the electric motor with rotating shaft.

1842

- Invention of the step-by-step pulse pointer telegraph – B. Jakobi.

1853

- In St.-Petersburg the joint-stock company of Russian electric technical factories «Siemens and Halske» «for manufacturing the subjects, finding application in the electrical engineering» is based. At the factory devices of radio telegraph were made, as well as the reception and transmitting spark radio equipment. In 1918 the factory was renamed into "Kozitsky Radio engineering factory".

1858

- The idea of quadruplex telegraphy providing message transfer on a single-wire line simultaneously towards each other – Z.Ja. Slonimsky. It was realized in 1874 in the USA by T.A. Edison.

1867

- Organization of the Managements of City Telegraphs in Russia.

1872

- The International Telegraph Agency for Russia to exchange messages with other countries.
- Invention of the electric lamp – A.N. Lodygin. In 7 years T. Edison (USA) invented the same type of lamp with a coal thread of enough durability, convenient for industrial manufacturing.

1873

- Conception of speed and direction of motion and the energy of stream – N.A. Umov. In 1884 J. Poynting (England) applied the idea to the electromagnetic energy. From here – the Umov-Poynting vector.

1875

- Invention of the first practically suitable source of electric illumination (candle of Jablochkov) – P.N. Jablochkov.

1876

- P.N. Jablochkov invented the first transformer (the transformer was also constructed by I.F. Usagin and L. Golar in 1882).

1877

- Designed and put into operation a military telephone line – Shtal.

1879

- A Russian student, subsequently the known physicist and biologist P.I. Bakhmetiev invented "telephotographer" – a system to transmit moving images. In the image sending device there was used selenium photo resistance moving on a spiral. At the reception the light source (a gas torch) was modulated by the signal.

1880

- The scheme of simultaneous telegraphy and telephony using one pair of wires (phantom chains) – G.G. Ignatyev.
- D.A. Lachinov proved the possibility to transmit the electric power on long distances with less loss at higher voltages.

1882

- City telephone exchanges started working in Russia.

1886

- In St.-Petersburg there was organized the technical school of the post-telegraph department transformed subsequently in the State Electric technical University.

1887

- A.G. Stoletov was one of many people who discovered and applied photo effect. The very first was H. Hertz in 1887. In 1888 A.G. Stoletov (Russia), A. Righi (Italy) and V. Galvaks (Germany) investigated the external photo effect.
- "The post-telegraph magazine" started being published in Russia.

- The invention of the system of centralized telephone system power supply – P.P. Golubitsky.
- The project of automatic telephone exchange on the basis of the automatic central switchboard – K.A. Mostitsky.

1888

- Professor of Moscow University A.G. Stoletov investigated the external photo effect, established the main laws of photo electronic and created the first photo cell with an external photo effect.

1890

- Invitation of the asynchronous short-circuited engine of the three-phase current. The invention of the transformer of the three-phase current – M.I. Dolivo-Dobrovolsky.

1892

- B. Rozing stated idea of existence of the molecular field causing spontaneous magnetization of ferromagnetics.
- Publication of the A.M. Lyapunov's paper «The General problem of the motion stability», where criteria of stability of dynamic systems on the basis of square-law functions were formulated.

1894

- A.S. Popov constructed the generator of electromagnetic fluctuations with coherer and invented the aerial.

1895

- The invention and design of a radio receiver with automatic synchronous detecting and the relay amplifier – A.S. Popov.
- On the 7th of May – demonstration of a radio communication – A.S. Popov.

Popov memorial in Kronstadt

1897

- B. Rozing from the St.-Petersburg University started investigation in the field of electrical image's transmission ("electrical telescopic").
- Foundation of the telephone L.M. Ericson factory, transformed later into the factory «Red Zarja».

1898

- Serial production of radio stations according to the system of A.S. Popov in France.
- The Russian military radio division – the Kronstadt spark military telegraph was organized.

1899

- The Polytechnic Institute, which became later the St.-Petersburg Technical University named after Peter the Great was organized.

1900

- In January at the First All-Russia Electrotechnical Congress K.D. Persky reported «a current state of a problem of electrovision over distance (televising)».
- On the 24th of August K.D. Persky made the report «Television by means of electricity» at the International Electrotechnical Congress in Paris. In this report the term "television" which later was widely adopted all over the world was entered for the first time.
- A.S. Popov invented the dot crystal detector with the contact of a steel needle to coal balls (6 years before the invention of a similar device by D. Pikard and, independently, by G. Danvud)
- The first practical application of radio - the battleship "General-Admiral Apraksin" stroke on stones at the southern extremity of the island Gogland. To save it Popov suggested to organize a radio communication between Kotka and Gogland. Ashore were put up masts for aerials.

During the salvage operation the communication between the coast, the island and the battleship was supported by wireless telegraph. The range of communication reached 45 km.

The same line was used to save 27 fishermen carried away in the sea on the ice. The ice breaker "Ermak" got the radiogram with the order to save the people.

- The Workshop to manufacture and repair the telegraphy devices started working in Kronstadt in September – it was the first representative of the Russian radio industry.
- On the 5th of August the Russian inventor engineer A.A. Polumordvinov offered the colour television system based, as the modern system of colour television, on the three-componental theory of colour, and recieved the patent on the invention: «Colour separator for the device to transfer images on distance with all their colours and shades».

1901

- A.S. Popov reached distances of 148-150 km for a radio communication between the ships on the Black Sea.

1903

- Comprehension of the role of radio-electronic struggle and development of recommendations about radio-electronic counteraction – A.S. Popov.

1904

- Application of methods of radio-electronic counteraction and regulation of telecommunication under wartime conditions – S.O. Makarov, Ukhtomsky.
- From the order of the commander of the Pacific fleet No. 27, March, 7th 1904: «…the reception part of telegraph should work all the time so that it would be possible to watch dispatches, and if the enemy dispatch was felt,

to report immediately to the commander and whenever possible to define an approximate direction of the enemy and to report on it».

On the 15th of April 1904 the wireless telegraph found another war application. The transmitting station «Gold mountain» and a battleship "Victory" created hindrances to the telegraph communication for the Japanese ships and by that sharply reduced efficiency of the artillery bombardment of the fortress Port Arthur.

It is possible to name the year 1904 the year of the Russian radio reconnaissance birth.

- Simeon Ajzenshtejn (1884–1962), a Russian scientist and radio engineer, received the patent on «System of simultaneous telegraphy and telephony without wires».
- The central telephone exchange of 60 000 numbers, constructed in cooperation with the company "Ericsson", begun to work in Moscow. For some years the station was technically one of the most advanced in the world.

1906-1907

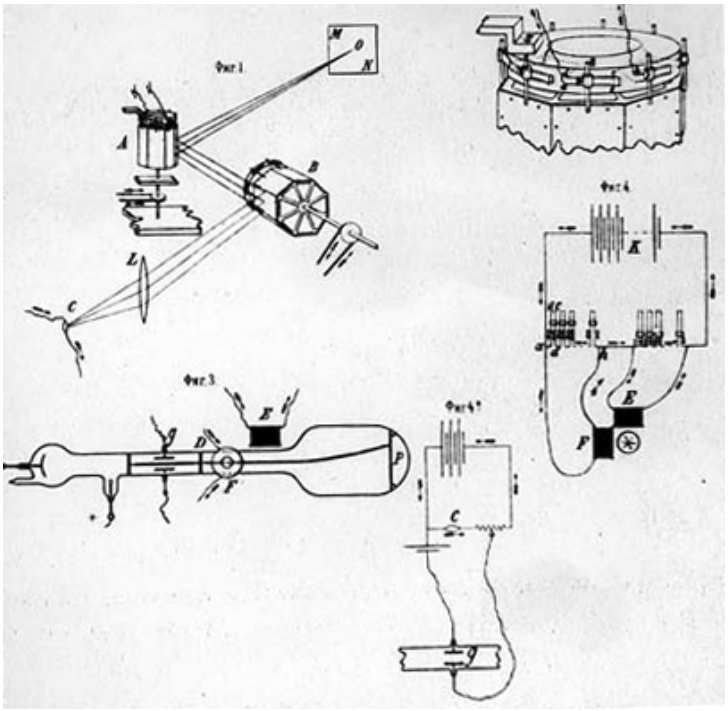
- N.N. Matusevich used radio signals to define a longitude.

1907

- V.F. Mitkevich was awarded the first Popov's Prize.
- S. Ajzenshtejn, organized in St.-Petersburg and headed «the Society of Wireless Telegraphy and Phones of S. Ajzenshtejn System» (since 1910 – «the Russian Society of Wireless Telegraphy and Phones»). Marconi was one of the structure management (20 % of share). S. Ajzenshtejn was one of the first among Russian researchers who made experiments on fadeless fluctuations generated by means of arcs.

  Since 1922 he lived in England. He had more than 20 patents.
- Russian scientist L.I. Mandelshtam suggested the idea and a practical realization of saw tooth voltage to control the cathode-ray tube's beam.

- On the 25th of July B. Rozing submitted the patent demand for «the Way of electric transmitting of images», based on application of a photo cell with the external photo effect in the sending device and a cathode-ray tube with modulation of the beam at the receiving end.
- B. Rozing submitted the patent demand for a television system with optiko-mechanical way of image creation on the screen of the improved Brown's tube at the receiving end – «the new or improved method of electric transmitting of images and the equipment for such transmitting» (submitted in December, received the English patent).



The *scheme of the B. Rozing's "privilege"*

- Alexey Alekseevich Petrovsky (1873-1942), a Russian radio- and electrical engineer, the Honored Worker of the Science and Techniques of Russian Federation (1941), published the first Russian theoretical textbook on radio engineering.
- D. Papaleksi began experiments on direction finding using radio.

- Ovanes (Ivan) Adamjan received the patent in Germany (and in 1908 – in Russia and in France) on a system of two-colored TV with simultaneous transmission of colour signals (the red-white image was transmitted by wires over 600 km). In the transmitter one gas tube radiated the white colour, another – the red one. A bit later he declared the three-colored device, named «arates» (“far seeing” in Armenian)

1908

- B. Rozing transmitted the black-and-white image (silhouette), using a mirror drum on the transmitting end and Brown's cathode-ray tube at the reception.
- The most powerful in Russia radio stations were built in Kiev and Zhmerinka. After a while the military department bought these stations for 70 000 rubles.

1909

- V.I. Kovalenkov built an electrovacuum diode for telephone signal translation.

1910

- B. Rozing demonstrated the television system invented by him.
- Russian physicist D.A. Rozhansky designed an electron beam tube with focusing of the beam using a short magnetic coil. The tube was intended for high-frequency fluctuations’ investigation.
- S. Ajzenshtejn built in Sevastopol a power arc radio station instead of a spark one, which had been working there since 1904.
- The factory RoBTiT began production of field radio stations “RoBTIT of 1910”. Some technical characteristics of the station: range of action up to 270 km; the transmitter wave band 400…2300 m, the receiver wave band 320…2500 m; the aerial of umbrella type, 12 beams and 12 counterbalances; height of the antenna telescopic mast 25 m.

1910-1913

- V.I. Kovalenkov developed (1910–1913) one after another three-electrode lamp, a two-net lamp and a sample of a generating lamp. All these devices demanded continuous pumping the air out.
- Radio-telegraph depot of the Russian navy manufactured in 1910-1913 spark transmitters for the station "RST-VN" of 2000 W power. In the receivers there were used detectors. 220 such stations were used onboard the Russian navy ships before the revolution of 1917.

1911

- On the 9th (22) of May B. Rozing, for the first time in the history of television, demonstrated the image transmitting with modulation of the cathode-ray beam at the reception.
- There was organized the Russian institute of a powerful radio systems.
- A.A. Petrovsky suggested the procedure for electromagnetic compatibility of telecommunication devices' calculation.
- A.N. Krylov designed a calculating machine to solve differential equations.

1911-1912

- The first trans-receiver for the earth-aircraft communication was designed under supervision of N.D. Papaleksi.

1912

- S. Ajzenshtejn began to design the first domestic radio lamps and radio equipment (1914-1917). He also began editing the first Russian radio engineering magazine «the Bulletin of telegraphy without wires». The magazine was published in 1912-1914.
- Systems of coastal radio stations for navigation safety were constructed in Russia.

- In 1912-1913 tens "sounding" radio stations capacity of 0.5 kW with the wave length of 80–160 m were used on the ships of a reserve and auxiliary fleet of Russia for communication between the navy ships. Factory RoBTiT also began production of special radio receivers for submarines.
- V. Vologdin, a Russian radio- and electrical engineer, a corresponded member of the Academy of Science (1939), the Honored Worker of the Science and Techniques of Russian Federation (1942), produced the first in Russia high frequency engine – a high frequency generator of 2 kW power with rotor's speed of 2000 revolution-per-minute. Generators, made by Vologdin, allowed to arrange the radio-telegraph communication between Moscow and New-York (1925). He was among the people who organized laboratory in Nizhny Novgorod (1918), where generators of his design were manufactured. He designed the first in the World high voltage mercury rectifiers with liquid cathode (1919), power metal rectifiers (1930). He worked out the theory of these generators and their circuits. In 1948 he was awarded the Golden A.S. Popov Medal and in 1943 and 1952 the USSR prizes.

1913

- Barrage countermeasures were designed.
- B. Rozing used at the receiver side a cathode-ray tube with magnetic focusing of the beam.

1914

- In August-September the first in Russia three-electrode lamp was made at the laboratory of RoBTiT under supervision of N.D. Papaleksi. They called it "a lamp of Papaleksi".
- N.D. Papaleksi and M.V. Shulejkin used the high-frequency Vologdin generator for radio-telephoning. They managed to cover 25 km distance. The quality of speech transmission was far from perfect. It became

possible to improve the quality only at the beginning of twentieth when high frequency continuous generators with lamps were invented.

- During three months two transmitting spark radio stations - Hodynsky in Moscow and Tsarskoje Selo near St.-Petersburg – of 300 kW power and a receiver station in Tver were built according to the Ajzenshtejn's design. The stations were used for communication with capitals of the Antanta countries.
- By the beginning of the First World War almost all navy ships of the leading countries were equipped with radio sets. The army radio communication also began to develop faster with the war beginning, though traditionally kept behind the naval.
- For the first time in Russia at the factory RoBTiT lamp amplifiers and heterodynes for reception of continuous fluctuations based on a beating method were manufactured.
- 100 kW spark radio stations were constructed in Moscow (on Hodynka) and Petrograd (Tsarskoe Selo) for communication with French and English headquarters. Further the powerful stations were constructed by the military authority also in Nikolaev, Tashkent, Chita and Kushka. Civil communication developed much slower – only few stations of 15 kW were built. On a whole by the beginning of the XX century Russia was behind other countries to use the radio communication.
- There was manufactured the first domestic radio direction finder – I.I. Rengarten.

1915

- V.I. Kovalenkov designed the first in Russia electronic telephone lamp amplifier. This amplifier was installed into the equipment of the communication line Moscow (Kremlin) – Petrograd (Smolny) in 1922.

- M.A. Bonch-Bruevich made some radio tubes to replace in the French reception radio station in Tver. After successful experiments he organized manufacturing of the domestic vacuum reception radio tubes.
- V. Vologdin made the machine generator for onboard radio station of the biggest plane of that time "Ilya Muromets".

1916

- The factories RoBTiT in Russia began manufacture of radio receivers, amplifiers and transmitters on electronic lamps, and also radio direction finders for needs of the army.
- S. Ajzenshtejn used the arc transmitter (of 300 kW, frequency 25 кГц) with the loopback aerial for communication with a submarine on the depth of 20 feet.
- Michael Shulejkin, an academician of the USSR Academy of Science (1939), pointed out the presence of side bands in the AM radio-signals. In 1918-1921 he supervised the radio laboratory of military-engineering management, since 1919 – professor MTU, where he opened the radio engineering faculty. The chairman of the society of radio engineers (1919–1929). Since 1938 – the head of the committee of radio communication of the USSR Academy of Science. The author of works in the field of radio-wave's propagation. Investigated influence of the atmosphere on the radio-wave's propagation, deduced formulas of a broadcast along a terrestrial surface. He also developed the theory and a design procedure of long-wave aerials.
- A Russian emigrant David Sarnov from «The Marconi Company» (USA) offered the idea of "radio music boxes" for domestic application. Unfortunately the idea was ignored at the beginning.

1918

- There was organized the "Russian society of radio engineers".

- Founding of the Physicotechnical Institute in Petrograd (St.-Petersburg).
- After the Red Army was formed the independent bodies of communication, and also the research organizations in the field of military communication were organized. In April, 1918 the Military radio engineering laboratory (BPTA) was formed. Professor M.V. Shulejkin was one of its first heads.
- In August the Nizhnij Novgorod radio laboratory – the first Russian research centre in the field of radio engineering – was organized. V.M. Leschinsky was the first head of the laboratory. Leading scientists and organizers: M.A. Bonch-Bruevich, V.K. Lebedinsky, P.A. Ostrjakov, A.F. Shorin, V.V. Tatarinov, V.P. Vologdin - were working there.

  In March, 1919, the laboratory started production of radio lamps. Later they built several transmitting stations – a radio telephone station on the Hodynsky field in Moscow of 5 kW (in 1920 the power was 12 kW and the station got the name "Komintern"), the station «New Komintern» of power 40 kW in 1926, a cheap transmitter of 1.2 kW for local broadcasting (by 1928 twenty five such transmitters worked in different cities of the USSR.

  They also produced the generating lamp of 300 W power (1923) and radio lamps with water cooling of the anode by with power of 25 kW (1923) and 100 kW (1925–1926).

  In 1924-1927 the laboratory carried out (with application of the directed radiation) the intercontinental communication with America on short waves, and also round-the-clock communication by the line Moscow – Tashkent. In 1928 the laboratory became a part of the Leningrad Central Radio Laboratory of "Trust of factories of a low current".
- M.A. Bonch-Bruevich designed the first Russian vacuum reception radio tubes with the aluminum anode. They were manufactured at the Nizhniy Novgorod radio laboratory under mark "ПР1" («hollow relays 1»).

1919

- M.A.Bonch-Bruevich designed the first power radio lamp with a copper anode and its outside cooling.
- The Higher military electro-technical school of the Red Army, which became later the Military Academy of Communication, was organized.

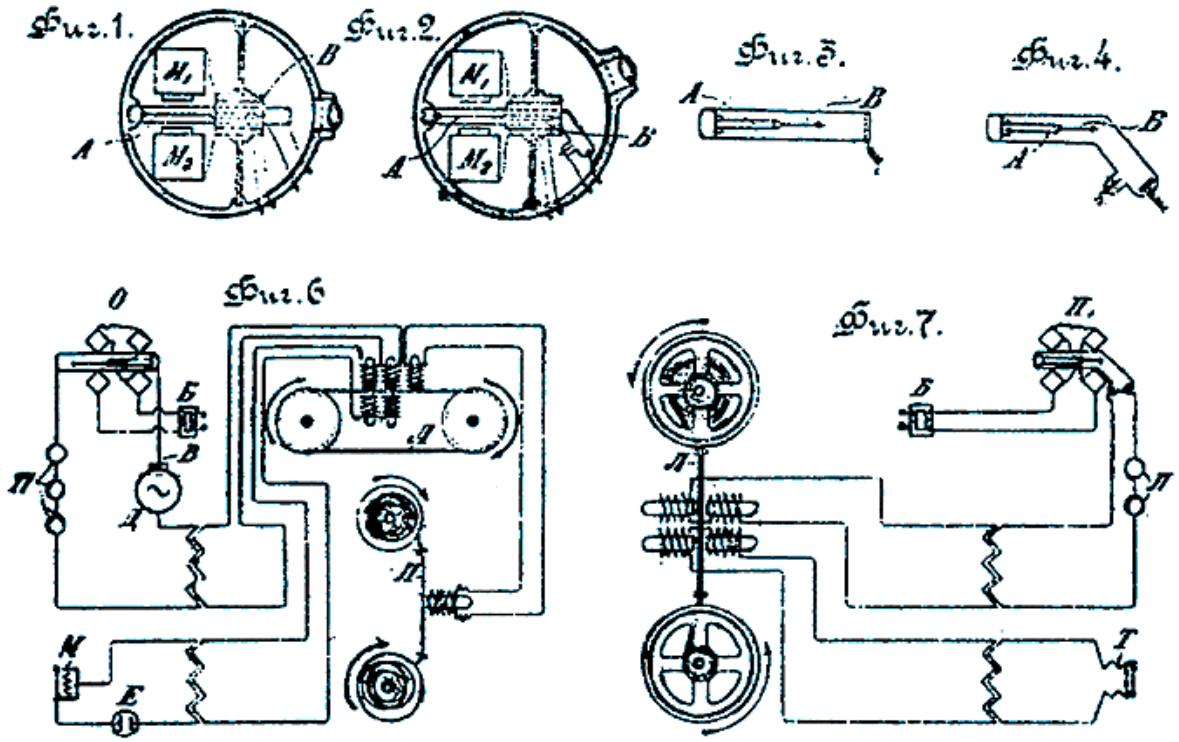
1920

- On the 17th of March the Council of Work and Defense decided to build the Central radio telephone station in Moscow with radius of action of 2 000 versts (1 verst =1.07 km).
- A Russian engineer S.N. Kakurin began to design a mechanical system with a disk of Nipkov for images broadcast.
- The group of M. Bonch-Bruevich began to design a TV system with commutation of the photo-cells at the transmitting side.
- L. Termen invented an electronic musical instrument «Termenvoks».
- In March a radio station of continuous transmission of 100 kW with the arc generator was constructed in Moscow Shabolovka str. under supervision of V.M. Lebedev. Originally it used the aerial suspended by two wooden masts of 160 m height.
- In April the radio telephone transmitter of the power about 1 kW was constructed at the Kazan base. There were used vacuum tubes (about 100 of them). Kazan was heard in Astrakhan (distance of 1 100 km), in Leningrad and in Rostov-on-Don. Two smaller transmitters were put on board of the ships "Dekabrist" and "Radishchev". They provided perfect communication during voyages between Kazan and Tsaritsyn.
- In September the radio telephone transmitter was used in Moscow for communication with Berlin. The signal was heard by the Germans, but could not be answered.
- The Pulkov observatory began to transmit time signals.

- M.V. Shulejkin worked out the theory of radio-waves' reflection from ionosphere. In 1923 he published the formula discribing electromagnetic waves' propagation in the ionosphere. The book became world known.
- Experimental radio telephone signals were sent from Nizhnij Novgorod to Moscow using a 40 W transmitter.

1921

- On the 17th of June in six squares of Moscow loudspeakers transmitted the oral newspaper and a lecture. Since that day they kept transmitting from 21 o'clock till 23 o'clock every day. They used the powerful loud-speakers equipped with two amplifiers of the Kazan base production.
- The first Soviet transmitting radio telephone station AK-23 was organized under supervision of A.I. Kovalenkov. It covered the range of 50 km.
- According to the Decision of Council of Work and Defense the "Special Technical Bureau", renamed later into "All-Russian Research Institute of Radio Engineering", was organized.
- On the 2nd of August in Lyubertsy (near Moscow) the broadcasting centre, which was the first centre of radio communication, came into service. The system of the broadcasting centers, which opened new ways of the radio communication development and allowed to centralize reception-transmitting of radiograms, was suggested by a Russian engineer K.I. Chetyrkin (the patent of 1919).
- There has been finished the construction of a metal tower of 150 m height. The tower construction was done according to the project and under the supervision of academician V.G. Shuhov. The tower started being used in March 1922, on the 19th.
- A.L. Minz designed the first in Russia lamp army radio station "ALM" (the initials of the author). ALM started being used in 1923. Before only spark transmitters "Telefunken" of German production were used.



The *schematic image of B.A. Rcheulov's system of magnetic image and sound recording (the patent of the USSR № 3803).*
Figs. 1, 3, 6 – recorder elements; Figs. 2, 4, 7 – elements of reproduction

1922

- Radiotelegraph “Komintern” factory was organized.
- B. Rcheulov suggested a mechanical system of TV.
- On the 1st of January there was organized the “Trust of factories of a low current”. In the same year in Petrograd on the industrial base of factory RoBTiT there was organized the Electrovacuum factory of the “Trust of factories of a low current” and a little later – the Central Radio Laboratory.
- O.V. Losev designed a semi-conductor device with negative resistance. The term «negative resistance» was introduced in 1928 by M.A. Bonch-Bruevich.
- On the 27th and 29th of May the Nizhnij Novgorod Radio Laboratory transmitted the first experimental radio concerts which were accepted at

the distance of 3 000 km. In the same year generating lamps of 25 kW with the copper anode cooled by water were produced at the laboratory.

- Started working the Central Radio Telephone Station in Moscow – the head was M.A. Bonch-Bruevich.
- On the 13th of January O.V. Losev (1903-1942), working as the laboratorian in the Nizhnij Novgorod Radio Laboratory, opened the ability of the detector from zincite (ZnO) to strengthen weak radio signals and to raise in radio engineering contours unfading fluctuations. Losev found that generation or strengthening of a signal is possible only in case of «negative resistance». In 1922 Losev suggested the circuit of the detector amplifier. In 1923 he constructed the detector regenerative receiver with the generating crystal, capable to accept station more remote than the usual detector receiver. He named this reciever "cristadin". Cristadins were produced by the industry and were rather popular among radio amateurs both in Russia and abroad. Losev's cristadin was a prototype of a modern tunnel diode, for which L. Esaki, A. Zhiver and B. Dzhozefson received in 1973 the Nobel Prize. Losev's priority in research of semi-conductor effects was recognized by John Bardin (an American of Russian origin) in his speech in 1956 when he and his colleges were receiving the Nobel Prize for the invention of transistor.
- On the 17th of September the Moscow radio telephone station transmitted the first broadcasting concert.
- B.A. Vvedensky together with A.I. Danilevsky made the first experiments in the radio communication on VHF in order to study the waves' propagation.
- In Russia under the supervision of scientists M.M. Bogoslovsky, S.A. Vekshinsky and S.A. Zusmanovsky there was begun mass production of generating lamps.

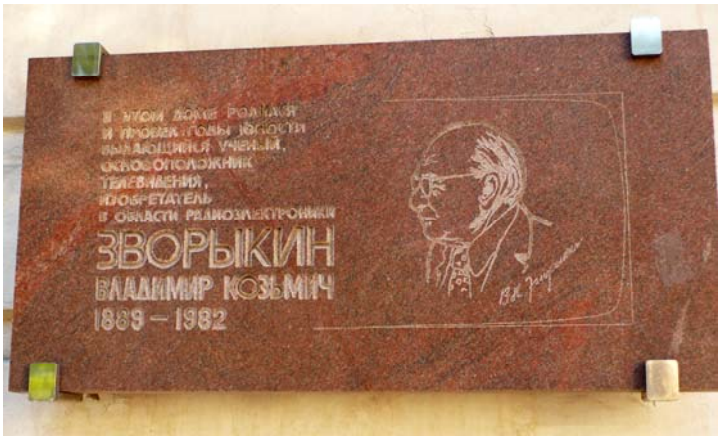
1923

- In January P.N. Kuksenko and A.L. Minz patented a ferroresonant circuit in which adjustment of a reception contour within a band of (500-2000) m was done by moving the iron core of the coil. When special ferromagnetic materials (ferrocart, magnetite, carbonyl etc.) started being used this method became popular in production of the receiver consisting of thin grinded powder pressed in firm staff by means of binding isolating materials. This method began to be applied for tuning receivers.
- The first loud-speaking receiver "Radiolina", consisting of a high frequency amplifier, detector, a low frequency amplifier and an electromagnetic loudspeaker was produced in Russia.
- May. The radio station “Komintern” started using new 2 kW lamps, which allowed to increase the power of the transmitter up to 30 kW.
- The electrovacuum factory of “Trust of low current” started mass production of receiving and generating lamps.
- M.A. Bonch-Bruevich and S.V. Tatarinov on the basis of the short waves’ propagation research suggested a mode of work on two waves (day and night) that made the round-the-clock distant radio communication more reliable.
- Vladimir Kozmich Zvorykin (1888–1982), a Russian engineer and an inventor, who emigrated to the USA in 1919, got the patent on iconoscope – the first transmitting television tube based on the theory of Kempbell-Svinton, formulated in 1911:

  «The image is focused by an external objective inside iconoscope. The high-speed electronic beam consistently scans the image across. Photo cells of the reading device are illuminated with different brightness and form the impulses depending on the light falling on them. Further the information is transformed into the electric video signal and transmitted to a receiver where there is a process of the image restoration, similar to the reading».

  By the end of 1923 V.K. Zvorykin developed a reception tube for reproduction of images – a kinescope. At the beginning the company

"Westinghouse" (Pittsburg, the USA), where Zvorykin worked, has not estimated the importance of the Zvorykin's invention. It was done later, in 1929, by the management of «RCA» after the demonstration of an improved system. So Zvorykin deserved a title «the father of television». In 1933 the improved Zvorykin's system was used for transmitting a video report from the «Empire State Building» being under construction in New York (there were 230 lines in the image).



Memorial plaque on the wall of the house, where V. Zvorykin was born

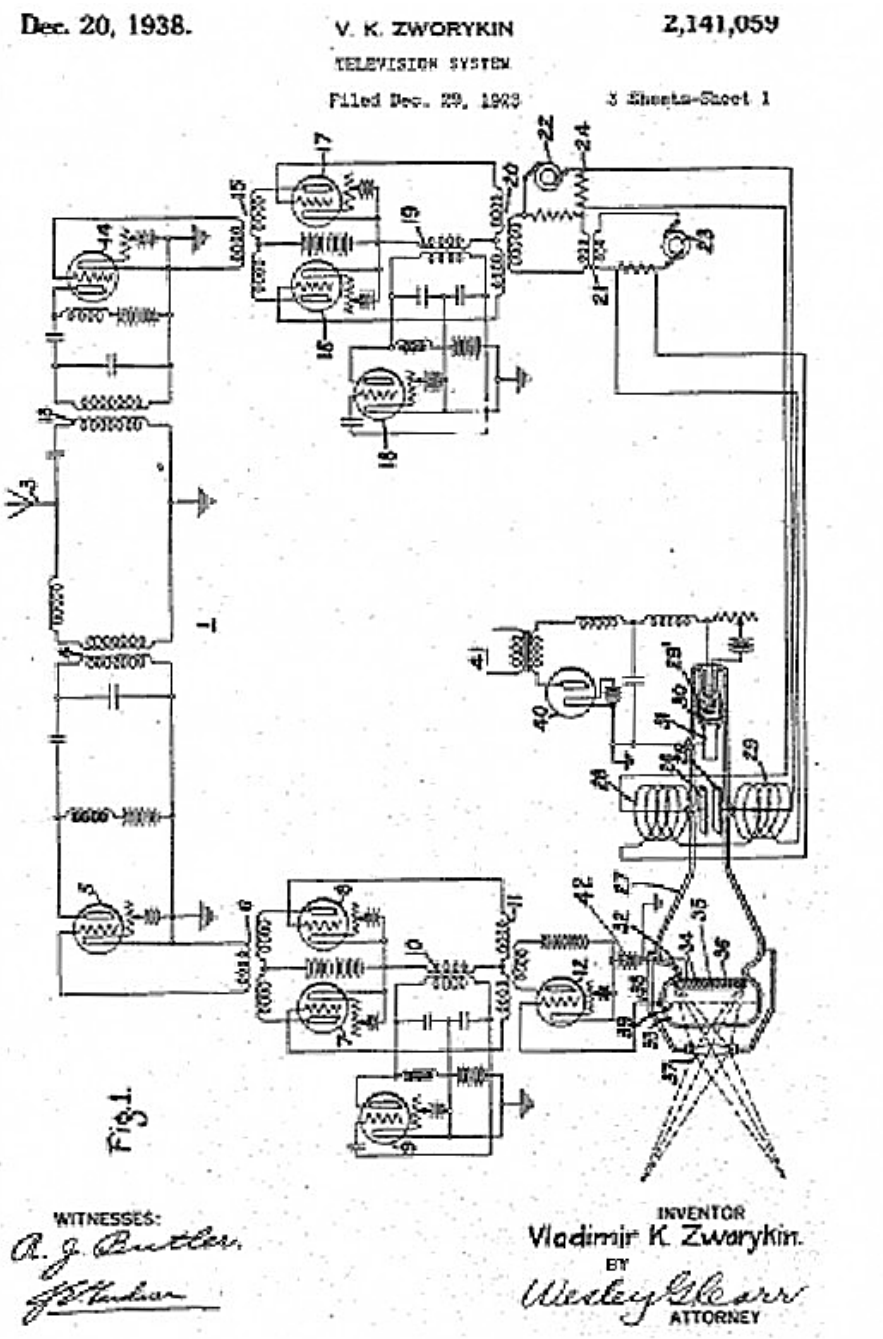
Murom, the Vladimir region, Russia.

It is written:
"In this house was born and spent his youth the outstanding scientist, the father of television, inventor in electronics Zvorykin Vladimir Kozmich 1889-1982"

- The Institute of Broadcasting Reception and Acoustics named after A.S. Popov was organized in the USSR.
- The factory named after Kozitsky organized production of receiving radio lamps. Radio receivers "БЛ", "БШ", rectifiers of long waves, receivers "БЧН", short-wave receivers "ПКЛ-2", amplifiers "УН-2", "УМ-4", "УПС" were very popular among radio amateurs.
- P.A. Molchanov suggested a device for meteorological radio-sounding.

1924

- B.A. Ostroumov from the Nizhniy Novgorod Radio Laboratory designed vacuum cathode tube with magnetic focusing. The tube was meant to investigate processes in high-frequency circuits.



The patent V.K. Zvorykin's application on the iconoscope

- V.A. Gurov from the Central Radio Laboratory developed optical-mechanical system to transmit the image using a shaking prism and a drum with lenses.
- On the 15th of July «the Society of radio amateurs of the USSR» was organized. In December it became the "Society of friends of radio of the USSR".

- The Central Radio Laboratory of “Trust of factories of a low current” designed broadcasting transmitters of power from 1,2 up to 4 kW. They were manufactured by the Kozitsky factory.
- On the 28th of July government of the USSR accepted regulation «About private receiving radio stations». This allowed to manufacture and to install receivers for «radio listening». The regulation said that the citizens had right to have their own radio receivers. It is possible to consider this day as the birthday of the domestic broadcasting radio. The decision also opened the door for the mass radio amateur movement.
- Mrs. A. Glagoleva-Arkadeva generated submillimeter waves (length of the wave 82 microns) by means of an arc generator.
- In September in Russia the industrial detector radio receiver «ЛДВ» («amateur detector broadcasting») was manufactured by the “Trust of factories of a low current” in Moscow. Further 5 updating modifications of this receiver were issued by the factory. The first broadcasting receivers "Radiolina" of the Leningrad “Kozitsky factory” were sold in the same year.
- On the 4th of October, the day of the Russian statesman M.V. Frunze funeral, the first radio reporting from the Red Square was organized by A.L. Minz.
- On the 12th of October the Sokolnichesky radio station constructed under A.L.Minz’s supervision started regular broadcasting at the wave 1010 m. The power of the station was 640 W, growing up to 1.2 kW.
- On the 23rd of November the station “Komintern” designed by M.A. Bonch-Bruevich started regular broadcasting.
- On the 24th of December the broadcasting station of 2 kW become operational in Leningrad.
- On the 27th of December the broadcasting station in Nizhni Novgorod

started working. The power of the transmitter was 1.2 kW. It was designed and manufactured by M.A. Bonch-Bruevich and S.I. Shaposhnikov. The improved version of this transmitter was called "Small Komintern" and since 1925 was produced as typical for local broadcasting.

- "Kozitsky factory" in Leningrad started production of radio receivers using domestic radio lamps.
- The Navy authority organized production of ground and airplane radio stations and radio direction finders of different types.
- Magazine "Radio Amateur" started being published. In 1946 it was renamed. The new name was "Radio".

1925

- On the 22nd of January the Nizhnij Novgorod Radio Laboratory started communication between Nizhnij Novgorod and Irkutsk over the distance about 4.5 thousand km on the wave of 23 m.
- On the 16th of February the first opera broadcasting was performed by the Sokolnichesky radio station from the studio in the House of the Unions in Moscow. Opera "Evgenie Onegin" was transmitted.
- S.J. Turlygin described experiments with magnetic cores made of the iron powder pressed by high pressure. He got excellent results while tuning the coils.
- On the 12th of October the Sokolnichesky radio station started regular transmission of concerts, operas and performances from halls of theatres, chronicle from streets and squares.
- "Committee of inventions" received application of B.P. Grabovsky, V.I. Popov and N.G. Piskunov on the first in the USSR completely electronic television system (the patent No. 5592). The first exemplar of the station was manufactured at the factory "Svetlana" in Leningrad.

- On the 23rd of November the Moscow radio station “Komintern” began regular broadcasting.
- The Soviet scientist A.A. Tchernyshev from the Leningrad Electrophysical Institute created optical-mechanical television system making the image by means of many-sided mirror drums and using the effect of Kerr in the receiver. He also sent an application on the device with a light valve for the reception of the image on the big screen and suggested the transmitting television tube with the semiconducting photocathode.
- The American engineer of Russian origin V.K. Zvorykin patented the idea of fully electronic color television, which became reality only 25 years later.
- I.A. Adamyan suggested a system of color television with consecutive transmitting of colours.
- B.A. Gurov put forward the idea of creation of "radio cinema" - the television transmitter with an intermediate film.
- B.P. Grabovsky designed a system with transmitting and receiving cathode tubes – «radio telephot». The system contained amplifiers, generators of scanning, devices of synchronization. The system was rather close to the ideas of the modern circuits. Unfortunately, the equipment of «radio telephot» was lost on the way from Tashkent to Moscow. So the author couldn’t demonstrate his idea and, what is worse, could not to finish work connected with this system.
- On the 16th of December L.S. Termen read a report at the “V congress of Russian physicists”: «Vision on far distances» and demonstrated the image of a moving hand on the screen.
- Vladimir Tatarinov (1878–1941), the Russian radio physicist, created the theory and an engineering method of calculation of short-wave directed

aerials on the basis of the suggested by him so-called method of induced currents.

1926

- The Vladivostok broadcasting station has become operational.
- On the 9th of January the Sokolnichesky radio station began regular broadcasting on short waves (90 m). Regular broadcasting on short waves has not been started in1926 in Europe yet.
- On the 20th of February the radio started regular broadcasting of the bell of the Kremlin Spassky tower clock.
- The Nizhnij Novgorod Radio Laboratory established the first short-wave lines of radio communication Moscow-Tashkent and Moscow-Vladivostok. These stations used short-wave directed aerials designed by V.V. Tatarinov.
- On the 25th of November in Moscow the most powerful in Europe (20 kW) broadcasting station of medium-frequency waves named after A.S. Popov started service.
- At the VI All-Union Congress of Physicists in Moscow a group of engineers from the Leningrad Electrophysical Institute under leadership of L.S. Termen demonstrated transmission of moving images by means of optical-mechanical television system.

1927

- On the 18th of March the most powerful in Europe 40 kW station "Komintern" started broadcasting.
- The head of the Aerologic Observatory of the city Pavlovsk near St.-Petersburg P.A. Molchanov patented a radiosonde for getting meteorological data. In 3 years three big spheres filled with hydrogen lifted radio equipment of 3 kg weight to the height of 9 km. Within 35 minutes P.A. Molchanov received radio signals. The signal from the

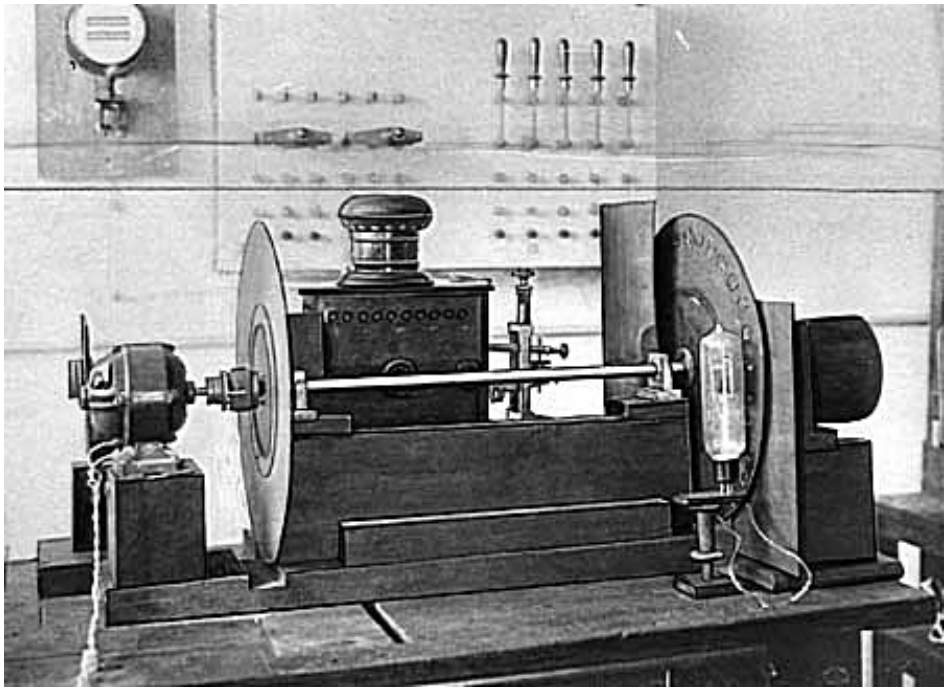
spheres was transmitted at once to the Weather Institute in Leningrad and to Moscow. One of these spheres was exhibited at the international exhibition of the air transport and specially mentioned by the traveler F. Nansen, who was the head of the exhibition.

- E.E. Slutsky suggested the concept of ergodicity to describe the properties of random processes.
- "Bureau of the Powerful Radio Manufacture" organized by A.L. Minz designed a number of power radio stations.
- A wire broadcasting city network was organized in Moscow.
- Beginning of operation of the first short-wave main line of radio communication Moscow – Tashkent.
- In September a polar radio operator Ernest Teodorovich Krenkel established the first short-wave communication in Arctic regions.

1928

- Boris Alekseevich Vvedensky, the Soviet radio physicist, forwarded «the square-law formula» for calculation of VHF propagation over the terrestrial surface within direct visibility. The formula considered interference between the direct wave and the wave reflected by the earth.
- In March in the course of two weeks short waves were used to encourage amateur movement. At this time a balloon with a pilot and a radio operator went into the air in Kuntsevo (near Moscow). It was there for 40 h. 32 min communicating with amateurs from the USSR and other countries. Radiograms were received from Kiev, Tomsk, Baku, Vladivostok and other cities.
- There were in the USSR 65 broadcasting stations with the general power of 192,64 kW operated; 177 transmitting stations of wire broadcasting; approximately 21 thousand wire receivers and about 70 thousand wireless receivers.

- The system of colour television with optical-mechanical scanning of the image (D. Baird, Great Britain) using the invention A.L. Polumordvinov (Russia) was developed.



System with a disk of Nipkov, 30th years of the XX-th century

1929

- The research assistant of All-Union Electrotechnical Institute Ju.S. Volkov submitted the patent demand on «the device for electric telescope in natural colours» – a system of colour television with consecutive transmitting of colours using a cathode tube.
- A.N. Kolmogorov suggested the set-theoretic axiomatic of probability theory.
- On the 21st of May the 100 kW station named after the All-Union Central Council of Trade Unions began experimental broadcasting. At that time the station was the most powerful in Europe. The station was designed and manufactured under leadership of A.L. Minz. Regular broadcasting started on the 28th of November.

1930

- Leningrad Institute of Engineers of Communication (nowadays the St.-Petersburg State University of Telecommunications) was organized.
- In January at the initiative of Professor P.A. Molchanov the first in the World radiosonde with the equipment developed by Professor I.G. Fejnman started working.
- On the 12th of January E.T. Krenkel, who was a member of the soviet expedition on the Franz Josef Iceland in the Arctic regions, established on short waves communication with R. Baird who was near the South Pole at the distance about 20 000 km. At that time it was a record.
- The Kozitsky factory started serial production of receivers EKL-4, EKL-5, RKE and others, and also the first in the USSR television receiver Б-2 with the Nipkov disc and later receivers ТК-1, Т-1, Т-2 with kinescopes.
- The Soviet physicist L.A. Kubetsky begun investigation of the secondary electronic amplification and submitted the author's demand for «the multiunit electronic device» – the multistage electronic multiplier.
- The research assistant of the Leningrad Electrophysical Institute A.P. Konstantinov designed an image transmitting tube with a bilateral mosaic made of photo cells with an external photoeffect and accumulation of charges (the application from December, 28th, 1930, the patent got in November, 30th, 1934). But it was not possible to give life to such difficult design at that time.
- L.A. Kubetsky prepared the demand for the invention of a way and the device of cascade electronic amplification of photocurrents (the photoelectron multiplier).

1931

- TV broadcasting with mechanical scanning began in the USSR.

- The American mathematician of Russian origin Sergey S. Chelkunov working in Bell Labs, investigated theoretically losses and dispersion in cables. His college O.J. Zobel invented the circuits providing equal attenuation in cables at different frequencies.
- On the 20th of January the broadcasting station of 100 kW power started functioning near Leningrad.
- In May the TV laboratory of All-Union Electrophysical Institute tried to transmit the image with 30 lines at the wave 56.6 m. The transmitter was designed by V. Archangelski. A bit later the same year Ja. Ryftin of Leningrad Electro-Engineering Institute enlarged the number of lines up to 64.
- On the 13th of May the USSR started regular broadcasting at ultra short waves. The station PB-61 used 5.8 m wave length. It was the first meter-wave station in the World. It was designed by A. Astafiev and V. Tcherenkov and built by B. Vvedenski.
- A.L. Minz suggested for the first time and then put to life the idea of block system of the broadcasting station "Komintern". The Soviet system of blocks was borrowed by Americans while building the powerful radio station in Cincinnati in 1934.
- Leonid Isaakovich Mandelshtam (1879–1944), the Soviet physicist, one of founders of school of the Soviet radio physicists, together with N.D. Papaleksi formulated a new method of excitation of electric fluctuations and created a parametrical generator of an alternating current with periodically changing inductance.

  Later 1938 L.I. Mandelshtam and N.D. Papaleksi developed the radio interferential method of correct measurement of distances, widely used in geodesy, hydrography, etc.
- On the 24th of September S.I. Kataev received the certificate № 29865 on the transmitting television tube called later iconoscope. Same year he

received the certificate № 94946 on the device for the moving images transmitting. In November V. Zvorykin submitted the USA patent demand on the transmitting television tube with accumulation of electric charges on the unilateral mosaic photocathode (similar to the device and a principle of action to S.I. Kataev's tube).

- On the 1st of October the station MOSPO began regular television broadcasting using the system with optic-mechanical scanning of the image with 30 lines (1200 elements) and 12.5 frames per second (wave length 379 m and experimental broadcasting at the wave of 720 m).

1932

- Alexander Pistolkors suggested the idea of using the phase modulation for signaling and also the circuits to give life to the idea.
- Leningrad started experimental TV broadcasting.
- L.I. Mandelshtam, N.D. Papaleksi and G.Ja. Schegolev created a direction finder of high accuracy (type MPTch), based on phase measurements. The international conference on nonlinear fluctuations in Paris noted the leading role of the Soviet school led by L.I. Mandelshtam and N.D. Papaleksi.
- V.A. Gurov and A.A. Raspletin executed the experimental TV signal transmitting using the optical channel.
- S.I. Kataev from the TV laboratory of the Electric-Physical Institute developed a vacuum reception television tube with magnetic focusing.
- Robert Nirenberg (1877-1939), a Soviet engineer and an expert in the field of ship equipment, the inventor of devices for sound underwater communication (1905), designed and constructed an acoustic self – controlling system to attack an enemy ship. He also executed the airship radio control and constructed the first in the USSR autopilot AP-1 (1932).

1932-1933

- In 1932 in the USSR, and in 1933 at session of the International Electric-Chemical Commission there was accepted the unit of frequency of periodic process - "Hertz", which entered later into the international system SI. 1 Hertz is equal to one full wave for one second.

1933

- A.L. Minz and the engineer N.I. Oganov developed the first domestic demountable triode capacity of 200 kW.
- P.V. Shmakov and P.V. Timofeev offered a construction of the transmitting television tube with the electronic image transmitter and scanning by the electronic beam. They received the certificate.
- The Soviet scientist G.V. Braude suggested a method of the corrected frequency characteristic calculation in case of input lamp amplifiers, which allowed improving the signal-to-noise ratio.
- In the USSR, the USA, England and Germany TV cathode tubes started being used for receiving the signal.
- In the USSR they started publishing the magazine "Telecommunication". The B.A. Kotelnikov's article «About throughput of the ether and a wire in a radio communication» was published. Three theorems were proved in the article. It proved that the function with the limited spectrum can be presented by a number of the instant values counted at the time intervals $\Delta t = l/F_{max}$. It also proved that such functions can be transmitted with any accuracy by means of the numbers following one after another at specified intervals and that it is possible continuously and evenly to transmit any numbers at regular intervals with a speed N=2F numbers in a second by means of the function having any small summands at frequencies higher than F.
- On the 20th of March there were begun tests of the most powerful at that

time 500 kW radio station “Komintern”. In this case A.L. Minz applied in practice of radio transmitting techniques and suggested by him the block system of power transmitter construction. On the 1st of May the station “Komintern” came into regular service.

- Novosibirsk and Tomsk started experimental TV broadcasting with 30 lines (1200 elements) and 12.5 frames in a second.
- B.A. Vvedensky started investigation of 60 cm wave propagation over the Black sea at the distance of 100 km. To build the transmitter he used magnetrons with splitted anode designed by A.A. Slutskin and M.A. Sliozberg.
- On the 30th of September the stratosphere balloon "the USSR" equipped with the radio station established the reliable communication line with the Earth from the height of 19 000 m. It was the World record.
- A.J. Hinchin discovered the relation between the power spectrum of a random process and its correlation function.
- L.A. Kubetsky suggested the idea of the supericonoscope – the combination of iconoscope and an amplifier with the secondary amplification of million times.
- P.V. Timofeev and P.V. Shmakov received the certificate on the cathode tube with image transfer – supericonoscope.

1934

- S.N. Bershtejn developed the theory of stochastic differential equations.
- B.K. Shembel and, independently, Ju.K. Korovin designed the first Soviet radar stations with continuous illumination.
- The USSR began regular TV broadcasting.
- L.A. Kubetsky manufactured and tested the first photoelectronic multiplier with amplification by1000 (a Kubetsky tube).

- L.A. Kubetsky suggested a variant of iconoscope with internal secondary amplified video signal.
- Soviet engineers B.V. Krusser and N.M. Romanova manufactured the first samples of Soviet iconoscopes. The experimental models of iconoscopes were also produced in Leningrad by A.N. Moskvin and in the Central Radio Laboratory by M.M. Fedorov and V.A. Gurov.
- The factory "Svetlana" in Leningrad started production of TV receiving tubes with electrostatic and magnetic focusing.
- E.G. Momot suggested the principle of synchronous radio reception.
- February-April. Within two months the continent received signals of the radio station of the camp formed on the ice in the Arctic Ocean by the crew of the sunk steamship "Cheljuskin". Communication with the people from "Cheljuskin" was uninterrupted.
- Kozitsky Radio Engineering Factory (Leningrad) started production of receivers “ЭКЛ-4” – one of the first receivers in which the reception part, the rectifier and the loudspeaker were put in one box.
- A group of the Soviet experts led by A.L. Minz and N.I. Stanov designed the original dismountable lamp considerably surpassing in the parameters foreign analogues available at that time.

1935

- Kozitsky Radio Engineering Factory (Leningrad) produced the first issue of TV receivers «Б-2».
- O.B. Lurie from the “Television Institute” designed the transmitter with 95 lines using a four-spiral disk of Nipkov and the electronic multiplier.
- S.I. Kataev put forward the idea of transmitter with reduction of the video signal frequency band due to the reduction of the frequency of frames (fewer frame television).
- P.K. Oshchepkov started using the first in the USSR pulse radars.

- A new big factory of radio receivers "Electrosignal" entered the partial operation in Voronezh.
- At the Aleksandrovsk Radio Factory there was begun manufacturing of radio receivers “SI-235”. These receivers won wide popularity of the population. The receivers were meant for the long and middle waves and worked on the principle of the direct amplification.
- I.E. Goron executed the experimental stereophonic sound transmission from the hall of the “House of the Unions” in Moscow.
- N.F. Alexeev and D.E. Maljarov developed the multichamber magnetron.
- I.H. Nevjazhsky suggested a method of spatial coherent addition of power.

1935-1936

- B.A. Vvedenski solved a problem of diffraction propagation of VHF in case of the spherical Earth. He got the formula for engineering calculations – called “diffraction formula”.

1936

- The first Soviet ionosphere station began to work at the Tomsk State University.
- The car ЗИС-101 was equipped with the first in the USSR wireless.
- Aleksandrovsk Radio Factory began serial production of the receiver СВД-1 – super heterodyne of the first class. It was followed by the modernized model СВД-М and, at last, СВД-9, received the widest circulation. The receiver had excellent for those times parameters: sensitivity not worse than 40 мкВ, selectivity -20 дБ. СВД-9 had high quality of sounding due to the good circuit of the LF amplifier with ton compensation.
- The Soviet scientist L.V. Moskvin developed sulphide luminophore with white luminescence for reception television tubes.

- The Soviet experts B.V. Krusser and I.F. Pesjatsky created the first samples of a TV transmitting tubes with image transfer – supericonoscope.
- The Voronezh factory "Electrosignal" manufactured a six-lamp super heterodyne radio receiver “6N-1”, which became the most popular in the USSR before the war.
- A long-wave 100 kW broadcasting station was built near Kiev.
- On the 17th of November UHF broadcasting station RV-81 (wave length 8.219 m) began to work in Moscow.

1937

- The first TV transmitter was designed in the USSR. In June, 1938, it was tested at the Leningrad experimental television centre. Leningrad started to broadcast (240 lines) and Moscow (343 lines).
- G.V. Braude developed a transmitting television tube without beams and of instant action to transmit films. He applied for a patent on “the cathode transmitting television tube with a double-sided capacitor target and a fine mesh located in front of it”.
- The magazine "Radio engineering" started being published in the USSR.
- The Soviet short-wave radio station started working as a part of the drifting station “Northern Pole-1”.
- The radio industry mastered manufacturing standard transmitters of power 2.5, 20 and 150 kW meant for local, regional and republican broadcasting.
- By the end of 1937 eighty broadcasting stations with the common power of 1997.5 kW, 3423 thousand retransmitting points and 321 thousand radio receivers operated in the USSR.

1938

- The Soviet engineer Isaak Nevjazhsky invented the system of power addition in the either.

- In August became operational the short-wave 120 kW station RV-96. At that time it was the most powerful in the World. The station utilized the original system of power addition in the either, invented by I.H. Nevjazhsky, and the wideband aerials invented by A.L. Minz. Signals of the station were received far abroad.
- In September the first Soviet television transmitter, in which the original electronic system of the Soviet inventor G.V. Braude, meant to transmit the films was applied, began to work in Leningrad.
- In October the Moscow television centre started experimental fully electronic broadcasting.
- Leningrad and Moscow TV stations began regular fully electronic broadcasting.
- Aleksandrovsk Radio Factory started production of the receiver MS-539 – five-lamp super heterodyne – and the advanced radio receiver СВД-10. Mass production of the last was stopped at the beginning of the war.
- There was published the book «Analytical methods of probability theory» by A.N. Kolmogorov.
- There were published the first volumes of “The course of theoretical physics” by L.D. Landau, E.M. Lifshits.

1939

- The Soviet scientist Alexander Pistolkors invented a loop-vibrator.
- The first-ever television broadcasting unit was organized in an apartment house in Moscow where the image accepted by one high-quality receiver was transmitted by wires to 30 points. The unit was designed at the laboratory of television by R.I. Budarov, V.N. Gorshunov, I.J. Sytin and others.
- The first radar stations “Reven” and “Redut” were designed and manufactured by the former factory of Marine department.

- At All-Union Television Institute N.M. Romanova designed and tested the experimental iconoscopes with mosaic on a semiconducting glass.
- A.S. Buchinsky (All-Union Television Institute) designed a reception television tube of a simple design with magnetic focusing and magnetic deviation of the beam. The tube was meant for mass production.
- In the USSR the All-Union Institute of Radio Engineering in extremely short time developed pulse radar to detect far away targets “Redut-40”. In July, 1940, the radar was accepted by the army under the name RUS-2. Before the beginning of the war 10 complete sets of station have been made. On the 22nd of July, 1941, the radar detected the approach of more than 200 German bombers near Mozhaisk. The fighters and the anti-aircraft artillery prevented the bombing in due time. Only few bombers managed to break the Moscow defense.
- A.N. Kolmogorov developed a technique of a linear prediction for stochastic processes with discrete time.

1940

- There was designed and manufactured the ship radar “Redut-K”. In April, 1941, it was put aboard a cruiser “Molotov” of the Black Sea fleet and participated in operations near Sevastopol and then in areas of Tuapse and Poti.
- N.F. Alexeev and D.E. Maljarov published in the “Magazine of technical physics” the description of multicavity magnetron for generation of powerful oscillation in a centimeter band.
- On the 27th of May the Moscow station RV-84 began regular broadcasting. It transmitted three independent programs simultaneously.
- The radio factory in Minsk began production of super heterodyne receivers "Pioneers", “KIM” and “Marshal ".

- Invention of the reflex klystron - N.D. Devjatkov, E.N. Daniltsev, I.V. Piskunov, V.F. Kovalenko.
- L.S. Buchinsky suggested application of the ionic trap in reception tubes to eliminate the ionic stain on the screen.
- P.V. Kuznetsov at the Television Institute invented the Soviet sample of the orthicon.

1941

- After the beginning of the Great Patriotic War the powerful low-frequency waves, medium-frequency waves and short-frequency waves broadcasting stations of Moscow were evacuated to the East areas of the country. So the central broadcasting was performed only at ultra short waves by a number of transmitters of power from 3.5 to 10 kW.
- There was organized the institute which became later the “Institute of Long-Distance Communication”.
- V.I. Juzvinsky invented the way of filtration which started the wide-band quartz frequency stabilization.
- There was organized the Leningrad Aviation Institute, now the University of Aerospace Instrument Engineering.

1942

- There was designed and manufactured the radar RUS-2S «Pegmatit-2». There was also manufactured the experimental radar «Gnejs-2» for aircrafts, meant for the meter frequency band, the power 10 kW. In July it was put aboard the aircrafts Pe-2 and Pe-3 and successfully passed the test. These radars received the first fighting application at the end of 1942 near Moscow, and then near Leningrad. In July, 1943, the radar "Gnejs-2" was accepted by the army. The governmental order was to manufacture 200 radars of this type. There were manufactured even more.

- There were organized special military units to provide radio frequency interference.
- N.F. Kurchev, I.M. Zavgorodnev, I.F. Pesjatsky, A.K. Belkevich, etc. under supervision of E.I. Golovanevsky designed television equipment to transmit the information from radars to the command unit of the fighters.
- L.I. Mandelshtam and N.D. Papaleksi considered a problem of a radar-location of the Moon and showed the way of its realization using available means.
- The report concerning filtration of random processes – N. Wiener (USA). Subsequently N. Wiener recognized the priority of ideas of the Soviet scientists in this area:

> "*My researches of these years closely adjoined the works of several Russian mathematicians. In Russia they also got a particular interest. For a long enough time I had a very original connection with the leading mathematicians of this country. I never met any of them and, I believe, even never corresponded with any of them. But Hinchin and Kolmogorov, two the most outstanding Russian experts in the theory of probability, had been working in the same area, as me. More than twenty years we came each other on heels: once they proved the theorem which I just was about going to prove, next I managed to reach the goal slightly before them. None of us, I think, does it intentionally. Simply we casually reached the greatest creative activity at the same time and owned more or less identical stock of knowledge*".

1942-1943

- In October near Kuibyshev (nowadays Samara) began to function (not at a total power) a super-power broadcasting station constructed by L.A. Minz (1200 kW). The station was meant to work on long and short waves. Fully it became operational in 1943.

1943

- About 9 thousand the various radio stations providing a reliable control of the army took part in the historical operation under Stalingrad.

1944

- E.K. Zavojsky opened the electronic paramagnetic resonance.
- June-July. 27174 radio stations of various types participated simultaneously in operation on liberation of Belarus from German aggressors.

1945

- Moscow Television Centre restarted broadcasting, the first in Europe.
- In the USSR there was accepted the governmental decree about the 50th anniversary of the invention of radio by A.S. Popov. The annual holiday was established “The Day of Radio” (on the 7th of May,) as well as the Popov Golden Medal and a badge «Honorary radioman».
- In Leningrad there was opened the Central Museum of A.S. Popov.
- In the USSR there was organized the Scientific and Technical Society of Radio Engineering, Electronics and Communication named after A.S. Popov.

1946

- In 1942-1946 the outstanding Soviet academician V.A. Fock received the correct decision of a problem of radio-waves’ diffraction on a spherical surface of the Earth (without taking into consideration the atmosphere influence).
- A.N. Schukin suggested the system “wideband amplifier-amplitude limiter-narrowband filter”.
- The analysis of the noise influence on the reception of pulse signals from the theory of probability’s point of view – V.I. Siforov.
- In August the Kozitsky Factory started production of radio stations “Urozhaj” ("Crops") intended for communication over short distances (to 30 km) in agriculture area.

- The first VHF broadcasting station with frequency modulation of power 1 kW was put in operation in Moscow.

1947

- In September the Central station started every day regular broadcasting of the third program on the medium-frequency and short waves.
- The VHF FM station of power 3.3 kW started broadcasting in Leningrad.
- After the break caused by the war the Leningrad television centre started broadcasting.
- There was organized Moscow Physics Technical Institute meant to teach future radio engineers.
- In May in the magazine "Radio" A.I. Berg published the article "The radar's origin" in which, in particular, he mentioned that A.C. Popov in 1897 observed reflection of electromagnetic waves from ships and spoke about possible application of this phenomena for development of a new area of the radio engineering, which we call now radiolocation.
- By the 800 anniversary of Moscow the capital broadcasting system together with units of various departments totaled over one million of radio receiving points.
- V.A. Kotelnikov's thesis «Theory of the potential noise immunity», where the problem of optimum statistical synthesis of receivers was discussed and the limiting restrictions on application of different types of modulation were analyzed.
- N.I. Kabanov discovered the effect of the decametric radio-waves' distant scattering reflection from the Earth.
- V.A. Kotelnikov suggested geometrical representation of signals.
- I.E. Goron, Ter-Osipjants, V.I. Parhomenko and V.S.Vajmbojm performed a three-channel sound recording on a ferromagnetic film and reproduction of high-quality with preservation of acoustic perspective.

1948

- The Moscow television centre was reconstructed to broadcast with 625 lines. Later this standard was accepted by the majority of the countries of the World.
- On the 27th of June there was opened in Leningrad the museum of A.S. Popov at the Electrical Engineering Institute where A.S. Popov was the first elective rector.
- On the 18th of August the Leningrad television centre equipped with the equipment manufactured by Leningrad factories and scientific research institutes began regular broadcasting.
- In August at the Kozitsky Factory there was manufactured the ten-thousandth copy of radio station "Urozhaj".
- On the 6th of December the radio conversation between Moscow and a train, moving on the way Omsk-Tatarskaja took place. The conversation was conducted between the Minister of Railways and the machinist of the steam locomotive Barabashin during selector meeting. At this meeting machinists of the railway transportation were awarded the government awards.

1949

- The All-Union Scientific Research Institute of Radio Engineering designed mobile radar for air targets' detection "Periscop" (P-20). The radar could identify all three co-ordinates of the target. At the institute there was also designed the radio relay line "Rubin".

1950

- The All-Union Scientific Research Institute of Radio Engineering designed the radar "Observatory" (P-50) for air targets co-ordinates' definition of and targeting fighters. The data were transmitted to the central post by the radio relay line RL-30.

- There were 3600 thousand wireless in use and 9700 thousand wire receivers in the USSR.
- The first Soviet electronic digital computer was designed under the supervision of S.A. Lebedev.
- Prof. P.V. Shmakov with employees demonstrated the work of the stereo television system created by them.

1951

- V.A. Fabrikant, M.M. Vudynsky and F.A. Butaeva found the way of quantum amplifying of electromagnetic waves.
- After reconstruction connected with transition to the standard of 625 lines the Leningrad television centre renewed broadcasting using mobile television station for field telecast.

1952

- N.G. Basov, A.M. Prokhorov in the USSR, C. Tauns, J. Tordon, H. Tsajger in the USA and J. Weber in Canada independently created the first quantum amplifiers and generators for the microwave band (masers). In 1954 there was created the first quantum generator on the bunch ammonia molecular beam – N.G. Basov, A.M. Prokhorov and C. Tauns.
- On the 25th of December the first transmission of a documentary program was executed by the amateur group of Tomsk engineers, postgraduates and students. In 1953 they organized the experimental broadcasting centre at the Politechnical University, then it was widened, modernized and became official State TV centre. On the 30th of April 1955 there was started regular broadcasting by this State TV centre.
- At the Riga factories they began manufacturing radio receivers of the first class "Riga-10" and receivers of the higher class "World". They also began to produce the first radio receiver on lamps of finger-type series – “Rodina-52”.

- The radar-tracking complex “Kama” and the radio relay line “Tsepochka” (chain) for stationary units A-100 of the system S-25 meant to protect Moscow against air attacks were developed in the USSR.
- At the factory “Krasny Octjabr” they began manufacturing the 5-lamp super heterodyne receiver of the 3rd class “Moskvich-3”.

1953

- Under the supervision of A.V. Krasilov there were developed the first in the USSR transistors.

1954

- Moscow began experimental broadcasting of colour television based on the successive principle. TV receiver "Raduga” (rainbow) was designed to receive these programs.
- N.T. Petrovich suggested a new method of signals’ transmission and reception, called later a method of comparison. The most popular became the relative phase modulation where the information was coded not by the absolute value of a signal phase but by the difference of phases between two neighbor signals.

1955

- Introduction of VHF FM broadcasting for which transmitters of a soundtrack of power of 3.5 kW were used.
- The radar altimeter PRV-10 "Konus” (cone) was built in the USSR.
- The first experiments with stereophonic transmission.
- The car "Pobeda” (victory) became the most popular radio-equipped car. At the beginning the receivers were put only on a part of these cars, and since 1955 the audio system became the standard equipment.
- The first stage of the Minsk television centre started functioning in summer. On the 1st of January 1956 announcer T. Bastun for the first time addressed the television audience of Minsk: «Good evening! We wish all

of you happy New Year! We begin our experimental program…». During the first year of the Belarus television only 4.5 thousand people received the programs. There was only one canal; the radius of action did not exceed 60 km.

By the middle of 50th

- The total number of vacuum devices produced in the USSR was more than 100 million pieces a year, and semi-conductor devices – more than 20 million. There were manufactured modern types of magnetrons of various power and frequency bands, klystrons, including super-power generating lamps, lamps of a running wave, photo electronic multipliers, electron-optical converters, various types of transmitting and receiving television tubes, powerful generating triodes, pentodes, tetrodes. The Aleksandrov Radio Factory was reoriented to manufacture the mass TVs "Records".

1956

- The firm “Henri de France” developed the system SECAM (sequential color with memory). In 1960 on this system there was an exchange of TV programs between Paris and London, in 1967 the system was accepted in the USSR.
- Mass production of the small-sized receiver on transistors “Minsk” began.
- Detection of the signal compression effect in the matched filter – J.D. Shirman, B.V. Naidyonov, V.N. Manzhos, Z.A. Vajnaris.

1957

- On the 4th of October at 19:28 Greenwich time the rocket 8K71PS was started-up from the cosmodrome Bajkonur. This rocket carried out to the near-earth orbit the first artificial sputnik (satellite) of the Earth, which transmitted telemetric information within five months. The space vehicle was put into orbit with a cycle time of 96.17 minutes and height 228/947 km. The new era in the history of communications had begun.

For the first time researches investigated the radio-waves' propagation in space using radio transmitters of decameter band put onboard the sputnik. The news agency "United press" (USA) wrote: "90% of talks about sputniks of the Earth were in the USA. As it happened, 100% of performance was in Russia…". The newspaper "Daily news" (USA) wrote: "Now we look silly enough with all our propaganda squeal when we asserted for the whole world that Russian trudge somewhere at the tail-end in the field of scientific achievements …".

- There was begun production of industrial TV systems.
- The firm named after A.S. Popov in Riga started production of the receivers of higher class "Festival" with distant control including distant tuning.

1958

- Ch. Tauns and A. Shavlob from the Bell Labs invented laser. In 1964 Ch. Tauns was awarded the Nobel price in physics. He shared the price with two Russian scientists who did the same research but did not publish the results – A. Prokhorov and N. Basov.
- The beginning of the navigation system of high accuracy "Luga" production.
- The radar-tracking system with the synthetic aperture of the aerial was invented by G.S. Kondratenkov, A.P. Reutov. In the western scientific and technical literature there were messages that already in January 1951Carl A. Wiley (USA), while doing the research on the system of the radar-tracking rocket ATRAN, understood that the reflected waves with Doppler frequency shift can be used in order to synthesize a radar with the increased aperture of the aerial and by that considerably improve its resolution.
- The first laboratory of radio engineering reconnaissance for land forces was organized in the USSR.

1959

- N.G. Bass, B.M. Vul and Yu.M. Popov put forward the idea of the semi-conductor laser.
- Moscow started experimental colour TV broadcasting with simultaneous transmission of colours.
- There were manufactured the first serial samples of the Soviet radio tape recorders.
- On the 7th of October the photo television system put onboard the space vehicle "Luna-3» photographed and transmitted to the Earth images of the invisible part of the Moon.

1960

- The system of sound stereophonic broadcasting with polar modulation was developed by L.M. Kononovich.
- Since March the experimental stereophonic broadcasting at VHF with polar modulation was executed in Moscow. In the same year stereophonic broadcasting was started in Leningrad and Kiev.
- V.A. Presnov (USSR), A.P. Izverin (USA) received GaAs monocrystals.
- The theory of non-stationary Markov processes' filtration was developed by R.L. Stratonovich.

1961

- The first in the USSR serial station of radio engineering reconnaissance NRS-1 was designed and manufactured (the head designer Prokhortchuk). The station provided co-ordinates' estimation at the range up to 60 km with the error small enough for artillery targeting. Three direction finders were put on motor vehicles UAZ-469 separated from each other by 30 km.
- The bilateral radio communication and transmission of the television image of first space pilot Ju.A. Gagarin from the space to the Earth during

the spaceship "Vostok-1" flight.

- There was designed a stationary radar-tracking three-co-ordinate station "Pamir" (P-90).
- Radar-tracking investigation of Venus – V.A. Kotelnikov.
- The factory VEF began production of the first portable transistor receiver "Spidola" which won wide popularity in Russia and abroad. On the basis of this receiver more perfect models were worked out: VEF-12, VEF-210, VEF-202 and some others.

1962

- J.M. Denisjuk suggested making holographic recordings in tick photographic emulsion (hologrammes of Denisjuk). The images received by means of these hologrammes have three-dimensionality and chromaticity.
- The bilateral radio communication between spaceships “Vostok-3” and “Vostok-4” and the television reporting from the space were performed. This report was broadcasted according to the broadcasting standard using the television network of the USSR and “Intervision”.
- A radio communication via the planet Venus was carried out in the USSR in November. On the 19th of November the word “WORLD” was transmitted from the Earth in the telegraph code, reached the planet Venus, reflected from it and, having passed the distance of 81 million 745 thousands kilometers in 4 mines 32.7 seconds, was received by the station on the Earth. The same method was used on the 24th of November. The words “LENIN” and “USSR” reflected from the planet surface were received in 4 mines 44.7 seconds. This signal passed in space of 85 million 360 thousand kilometers.
- V.A. Kotelnikov began the radar-tracking investigation of the planet Mercury.

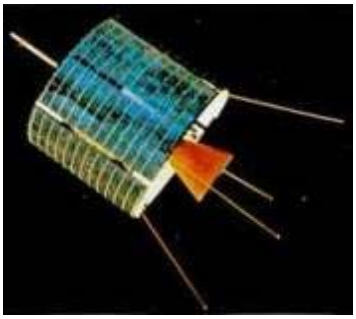
- On the 1st of January there was cancelled the necessity of registration of radio and TV receivers and as well as the monthly tax for using them.
- The radio station “Yunost” (youth) began to broadcast.

1963

- P.G. Borzjak, O.G. Sarbej, R.D. Fedorovich discovered the cold electron emission which took place if the current went through thin metal films with island structure.

1964

- The round-the-clock information-musical program "Majak" began to work on the 1st of August.
- Generation of signals of the highest at that time (and till 1974) frequencies of 60 GHz was performed by means of the sapphire laser.
- On the 22d of August the experimental communication satellite “Molnija-1” was put on the elliptic orbit (394/39 855 km, orbital period 715 min.)
- Scientists from the Institute of Applied Physics of the Academy of Science of the USSR made the first gyrotron (mode TE_{101}, power 6 W, cm waves)



Communication satellite «Early Bird» (USA)

Communication satellite "Molnija-1" (USSR)

Communication satellite "Horizon" (USSR)

- Ja.B. Zeldovich, A.G. Doroshkevich, I.D. Novikov spoke out about possibility to detect the relic space electromagnetic radiation of high enough intensity with temperature of some degrees which was discovered

experimentally by the American astrophysicists A. Penziasom and R. Wilson in 1965 (existence of the relic radiation was predicted by G. Gamov 20 years before it was detected experimentally).

1965

- H. Kogelnik developed a holographic method of recording and restoration of the wave front.
- A group of the Soviet military communication satellites of type "Strela-1" was put onto the orbit in the USSR («Kosmos-54…90»).
- Exchange of TV programs between Moscow and Vladivostok.
- On the 23rd of April the first operational communication satellite "Molnija-1" meant to retransmit TV programs, telephone and telegraph messages was put on the high elliptic orbit (548/39 957 km, an orbit period 720 min.) in the USSR. Further development of the program led to creation of the national network of TV broadcasting and the communication line "Orbit".

  The satellites "Molnija-2" and "Molnija-3" provided retransmission at higher frequencies and the increased throughput. The “Orbits” allowed to relay radio and television signals on the territory of the USSR within 8-10 hours a day. “Granit”, “Ekran”, “Horizon”, “Express”, “Luch”, “Radio” and others became the following generation of communication satellites.
- There was published the book «Distant troposphere propagation of ultra-short radio-waves» in which the results of experimental research of the far troposphere wave’s propagation over terrestrial paths in the central regions of the European territory of the USSR were given. The research began in the mid-fifties and was done by the collectives of Artillery Radio Engineering Academy of the Soviet Army (Kharkov), Radio Scientific Research Institute (Moscow), Radio Engineering and Electronics Institute (Moscow) - (A. Prosin V. Troitsky, Y. Shifrin and others). The average level of the signal was 8-12 дБ lower than the one received in the USA,

England, France and Japan. This difference could be explained by the specific environmental conditions. On the basis of this research in 1965 B.A. Vvedensky in the co-authorship with M.A. Kolosov, N.A. Armand, A.I.Kalinin suggested the engineering method of the field attenuation function's calculation in the band of 3-150 cm over terrestrial paths 100-800 km long.

- At the Krasnoyarsk radio factory there was finalized the design and begun production of the first in the USSR troposphere communication station "Korvet" P-133.

1966

- Television images of a lunar surface panorama were transmitted to the Earth from the board of interplanetary spaceship "Luna-9" which soft-landed on the Moon.
- Broadcasting on VHF was conducted in 165 big cities of the USSR. Three-program VHFs FM radio stations were developed for these cities with output power of 15 kW each.

1967

- In the USSR were 41.8 million wireless receivers and 38.9 million wire receiving points, the daily volume of broadcasting made 1000 hours.
- Exchange of the colour television programs between Paris and Moscow took place.
- The beginning of regular colour broadcasting using the Soviet-French system of colour television SEKAM.
- Organization of the satellite television broadcasting by means of the national system "Orbit". There were built the first 20 distributive stations including space and land objects. Since 1972 the construction of the stations for the decimeter band was begun. In 1984 under the program "Orbit" worked more than 100 land stations, from them more than 10 –

receiving-transmitting. The system provided a radio communication and television broadcasting practically for the whole territory of the USSR.

- The communication satellite got and then transmitted to the Earth its colour television image.
- Television helped to control from the Earth the process of the artificial satellites «Kosmos-186" and "Kosmos-188" docking on the orbit.
- Great Britain (BBC) and then the whole Western Europe accepted the 625-line standard of telebroadcasting PAL (Phase Alternation by Line). The USA and Japan 525-line NTSC (National Television System Committee), France and the USSR have chosen SECAM (Systeme Electronique Couleur Avec Memoire).
- On the 5th of November the Ostsnkino station in Moscow began functioning. The antenna tower was and is 533 m tall (the designer N.V. Nikitin). At the beginning there were broadcasted four TV and three radio programs from this tower. The construction was going on and finalized in December 1968.

1968

- The colour image of the Moon was received.
- V.N. Troitskii published he book “UHF wave propagation in mountain areas”, where he solved the problems of waves’ diffraction on the rough irregular surfaces, produced experimental data concerning diffraction on mountains of different profiles in the wide frequency band, compared experimental results with the calculated ones and introduced a criterion of irregular surface’s influence on the diffraction field in the shade.

1969

- On the 20th of July 600 million onlookers watched the first transmission from the Moon.

- Radio firm in Krasnojarsk finished the design and started production of the phase-differential navigation system “Kashalot”.

1970

- There was performed control of the robot working in the space object.
- A self-propelled device “Lunohod-1” was delivered to the Moon and controlled from the Earth. The device sent to the Earth the pictures of the Moon surface.

1971

- In November there was organized the international body of space communication (“Intersputnik”). According to the data of 2000 year 24 countries and more than 100 state and private companies became members of this body. They use the Russian space segment consisting of satellites “Horizon”, “Express” and “Gals”.
- Jores Alferov invented semiconductor devices’ hetero-structures – illuminators and photo-receivers for fiber-optics communication.

1972

- There were produced the first domestic receivers with microcircuits – “Ukraina-201” and “Ural-301”.

1974

- The USSR built the biggest radio telescope with multi-element antenna array. The antenna’s area was 150 000 square meters.
- More than 1000 broadcasting stations of different power were in action in the USSR. Population exploited 120 million wire- and wireless receivers.

1975

- Stations “Venera-9” and “Venera-10” delivered satellites to the orbit of Venus. Landers of both stations were equipped with panoramic TV cameras which transmitted images of the Venus’ surface for about an hour. Satellites performed a role of retransmitters.

1976

- The radio industry of the USSR let out 8.4 millions radio receivers and radio-gramophones, the number of radio receivers reached 66 millions.
- The first satellite system of the direct television broadcasting “Ekran” was installed.

1977

- In the USSR there was designed a transported three-co-ordinate radar of all-round surveillance “Mashuk”. The radar was meant to detect and support aerodynamic targets and rockets under difficult noisy conditions.
- The largest radio telescope RATAN-600 with a ring antenna reflector of 600 m diameter was constructed.

1978

- The first Soviet radio amateur communication satellites “Radio-1” and “Radio-2” started working on the orbit.

1979

- In Moscow the English company “Multitone” developed the first system of a personal call (paging) “Radio search” with coverage of all the city territory. The system appeared thanks to the preparation for the Moscow Olympic Games and originally solved a problem of the fast transmitting of commands to the executors of solemn actions and for coordination of their actions. The system worked on frequency about 43 MHz.

1980

- Working out of radar ST-68 – mobile three-co-ordinate radar for detection and tracking of the small targets in presence of active and passive interferences and reflections from the terrestrial objects under difficult meteorological conditions was finalized.

1981

- The straight line of communication Moscow-Delhi was put into operation.

The average distance of the line between the Soviet (height 2300) and the Indian (height 1757) points was of 697 km over mountain ridges of Hindu Kush. There was utilized mechanism of distant troposphere propagation of VHF.

Stamp block issued to co memorize the telephone conversation between I. Gundy and L. Bredgnev via the troposphere radio link

1982

- In Leningrad at the Television Institute there was finalized and then manufactured and shown at an exhibition in Montreux a set of equipment for digital television studio, including the equipment of the digital stream compress. This event significantly affected the large-scale development of methods and tools for the digital TV broadcasting. According to the suggestion of the Soviet specialists M.I. Krivosheev and V.A. Khleborodov, there was developed and adopted the international standard for digital encoding of the video signals – "Recommendation 601".
- Start of the satellites GLONASS (Global Orbiting Navigation Satellite System) launch. The group consisted of 21 major satellites and 3 standby ones. These satellites were on the orbit with the orbit period of 11 hours

15 min. From the altitude of 19 100 kilometers they transmitted signals at one frequency, using the same pseudo code. Satellites were manufactured by the Scientific Production Association of Applied Mechanics, Zheleznogorsk, Krasnoyarsk region (now – the corporation “Information Satellite Systems”).

1983

- The soviet interplanetary spacecrafts “Venera-15” and “Venera-16” began to take radar imagery of Venus and transmitted the information to the Earth (work manager Kotelnikov).
- There was created the automated complex of passive ground station’s positioning “Igla-5” and the missile complex 9K79 with a missile “Tochka-1”, equipped with an anti-radar homing head.

1984

- The radar measurements of Venus by unmanned interplanetary stations – A.F. Bogomolov
- At the Krasnoyarsk Radio Factory there was finalized the design of the digital station for troposphere communication “Brig-2A”.

1986

- From space to the Earth there were transmitted television images of Halley's Comet nucleus from the trajectories of spacecrafts “Vega-1” and “Vega-2”.

1988

- The fiber-optic communication line Leningrad - Pine Forest 120 km long began to work.

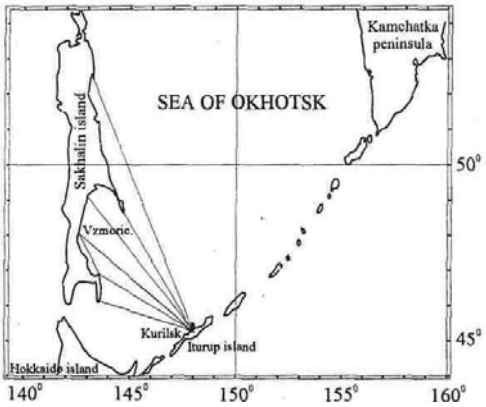
1989

- Began to work the satellite system, “Moscow-Global”, which provided reception of Soviet television programs by nearly all countries of the world.

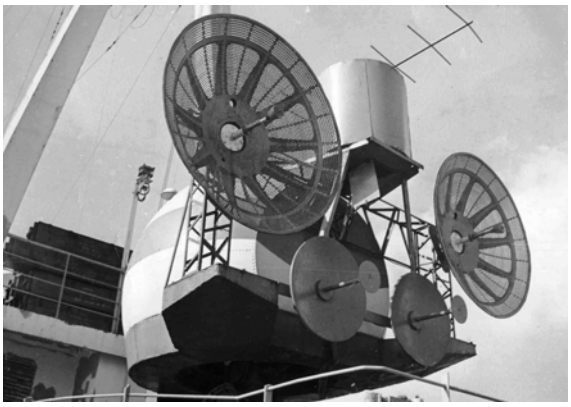
- There was put to the near-earth orbit a space observatory “Granit” with X-ray telescopes.

60-90-ies.

- There was carried out the extensive study of troposphere VHF wave propagation over marine routes (the Atlantic Ocean, the Black Sea, Mediterranean, Caspian Seas, Sea of Okhotsk, Pacific Ocean, inland seas) in 60-90-ies of the XXth century.



The scheme of the Okhotsk Radiophysics paths of observation, TUSUR



The research ship "Academician Shirshov" and TUCSR experimental equipment

TUCSR experimental equipment at the Iturup Island (Kuril Islands) in 70 th

The works involved groups of the Research Institute of the Navy of the USSR (Leningrad) under the leadership of I.I. Freiman, the Institute of Radio Physics and Electronics of the Ukrainian SSR Academy of Science (Kharkov) under the leadership of I.E. Ostrovsky, the Siberian Physical-Technical Institute (Tomsk) under the leadership of V.A. Filonenko and

V.B. Fortes, the Tomsk State University of Control Systems and Radioelectronics (TUCSR) under the leadership of G.S. Sharygin and several other organizations. There were more than 40 voyages of specially equipped ships in the waters of the oceans, organized stationary sea polygons in the northern Caspian Sea, the eastern Black Sea and the southern part of the Okhotsk Sea.

1990

- There were 800 millions TVs in the world, among them 90 millions in the Soviet Union. Every year all countries produced 70 million TV sets, including 14 million in China, 13.6 million in Japan, 9.7 million in the USSR, 9.6 million in South Korea, 3.8 million in Germany, 1.2 million in France. On every 1000 people there were 646 television sets in the USA, 457 in the UK, 365 in France, 310 in the USSR. According to experts, by 2000 the number of television sets in the world would exceed 1.3 billion.

1991

- The first in Russia mobile communication networks were put into operation in Moscow and St. Petersburg.

1992

- There was designed a three-co-ordinate radar “Gamma-D” of medium and high altitudes with the phased array antenna. There was begun development of the mobile three-co-ordinate radar “Gamma-S1” for detection, tracking and targeting.
- A program of the system of satellite communication and broadcasting development “Russia" was accepted. The program meant development of three subsystems: the fixed-satellite services, mobile communications and direct television broadcasting.
- In September, D. Zimin organized the factory “VympelCom” involving as founders the factory “Impuls”, the Radio Engineering Institute named

after Minz and a number of other enterprises. In June ”VympelCom”, together with American entrepreneur Augie Fabeloy deployed in Moscow a small pilot system for mobile communication standard AMPS with an initial capacity of 200 subscribers. In January 1993, “VympelCom” received a license of the Ministry of Communication to provide cellular services in the AMPS standard in Moscow.

1993

- Entered into service the digital underwater fiber-optic communication line Denmark - Russia (Kingisepp), which initiated the participation of Russia in the creation of the global ring of digital communication.
- On the 28th of October Moscow City Telephone Network, Deutsche Telecom (DeTeMobil), Siemens and several other shareholders formed a private limited company MTS (Mobile Tele Systems). On the 19th of November MTS received the first license to provide cellular services via GSM. On the 15th of May, 1994, MTS committed the first call, on the 7th of July, 1994 MTS connected the first customers.

1994

- There was launched and put into operation a satellite “Gals” for a system of direct television broadcasting.

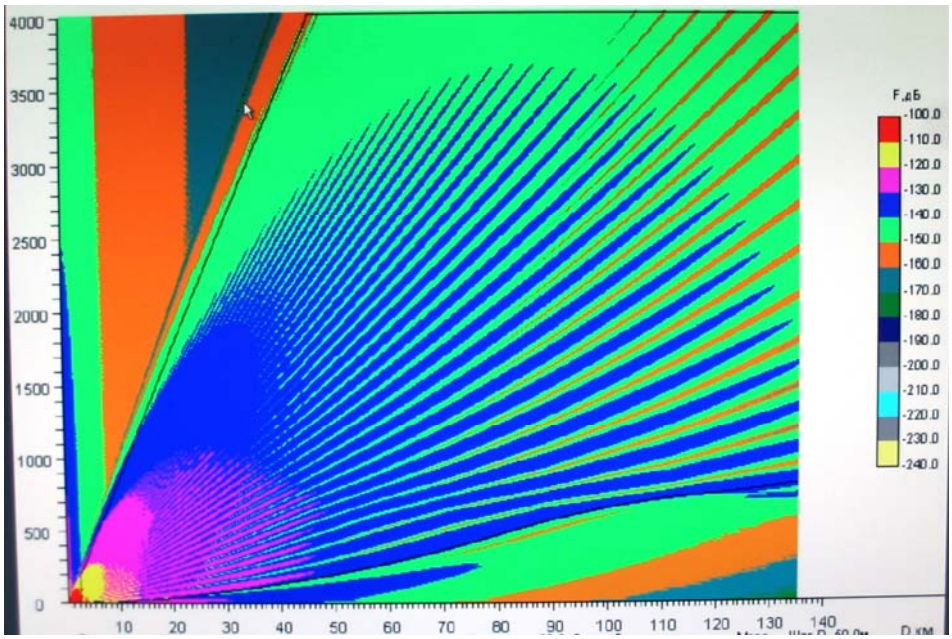
1995 - 1996

- There was finalized the first phase of construction of communication superhighways (Russia - Denmark, Italy - Turkey - Ukraine - Russia, Russia - Japan - Korea, Moscow - Khabarovsk) on the basis of the digital fiber-optic, radio relay lines and modern digital equipment.

2000

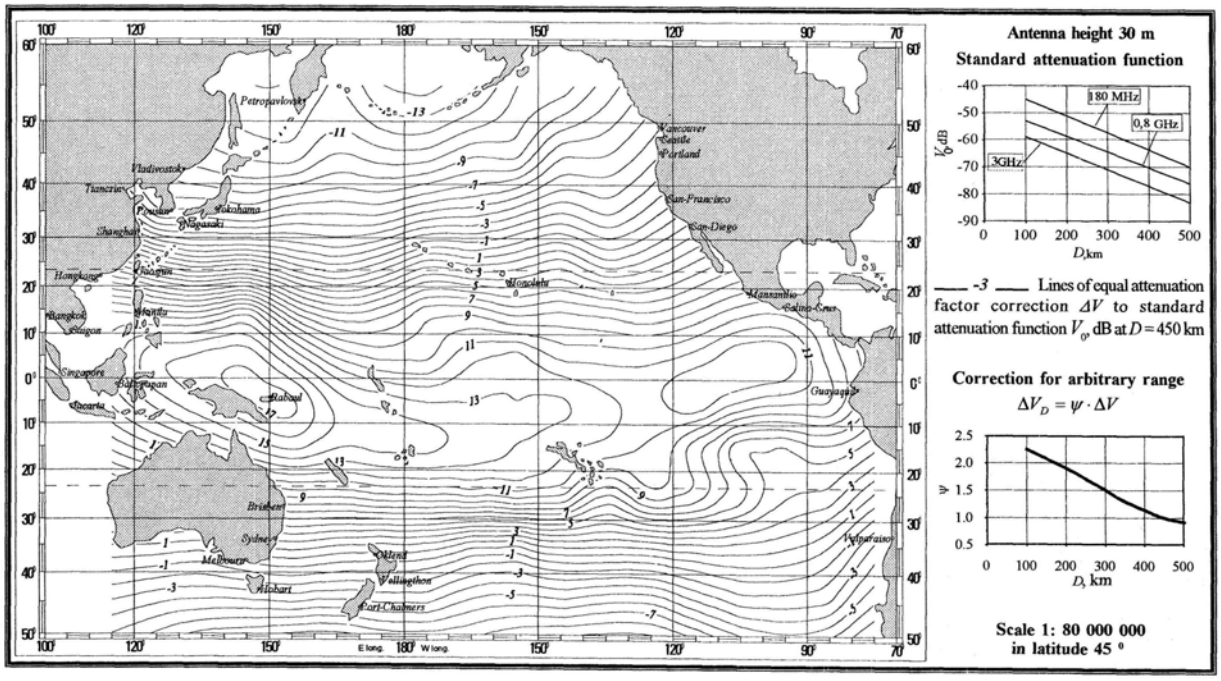
- In the Tomsk State University of Control Systems and Radioelectronics (the group of Professor Ju.P. Akulinichev) there was developed a system of operational forecasting of radiation sources observation based on the numerical solution of the wave parabolic equation. The basis for this

calculation was the vertical profile of refractive index, defined according to the upper-air sounding or other means.



Example of the result attenuation factor decrease forecast for the vertical plane in the area of sight and diffraction. The horizontal distance in kilometers, vertical - in meters

- On the 2d of July Nizhny Novgorod began an experimental digital TV broadcasting according to the European standard DVB-T for the first time in Russia.
- Launched a new generation of communication satellites “Express-A”.
- Edited by G.S. Sharygin there was published “Troposphere Radioclimatic Atlas of the Pacific Ocean”, containing 139 maps with contours of mean values of all main statistical characteristics radiometeorological parameters and radio in the far troposphere propagation: distance to radio horizon, attenuation in hydrometeors, Doppler spectrum width, vertical sublobing of antenna lobes, attenuation per unit length in the diffraction zone, attenuation factor in the FTP zone, slow variation of attenuation factor, coherence parameter in the FTP zone, interval of the temporal and



One of the Troposphere Radioclimatic Atlas of the Pacific Ocean pages

cross correlation of the signal fast fluctuation, attenuation factor in the near-the-water ducts, fast phase fluctuation, polarization ratio and its fluctuations. Accounting the area of measurements and seasonal variations in signal parameters can significantly reduce the systematic error and the uncertainty of its prognosis. For example, the standard deviation estimates of the attenuation factor were reduced from 10-15 dB to 5.8 dB.

ALL RUSSIAN RESEARCH INSTITUTE OF RADIO ENGINEERING (MOSCOW)

The Institute worked out more than 50 different types of radars. Almost all domestic enterprises of the radar profile started their activity with production of radars designed at the Institute. There were manufactured over 10000 radars and about 3000 were delivered to many countries abroad.

1921

- In accordance with the decree of the Russian Federation and the mandate signed by V.I. Lenin there was organized a Special Technical Office (STO)

1921-1939

- STO conducted design of armaments for the Red Army, Air Force and Navy: distant control devices of explosions, communications, aerial bombs, aerial aims, radio devices to control airplanes and ships, samples of mine-torpedo weapons.

1937

- STO was transformed into the Scientific Research Institute (then RIRE)

1939

- Start of design of radars meant to detect aircrafts.

1940

- The radar “Redut-40” (RUS-2) was taken by the army. There was designed the naval radar “Redut-K”.

1942

- Design and production of the radar RUS-2S (“Pegmatit-2”). Design of a prototype of the first Soviet airborne radar “Gneiss-2” of meter band with a radiated power of 10 kW.

1941-1945

- Being in the evacuation in Barnaul, RIRE was developing radars P-2, P-2M, P-3 (“Pegmatit-3”) of meter wave band, the airborne radars “Gneiss-2M”, “Gneiss-5”, “Gneiss-5M” for the Air Force and Marine aviation, the marine radars “Gujs-1” and “Gujs-1M” for detection of surface and air targets. There were manufactured and delivered to the army more than 700 radar stations.

1949

- There was designed the 10-centimeter radar “Periscop” (P-20) which became a prototype for a large class of radars meant to detect air targets and to estimate their co-ordinates. There was designed the relay line “Rubin”.

1950

- Design of the Radar Observatory (P-50) to determine the co-ordinates of air targets and guide fighters with transmitting the data to the command post of the air defense forces. There was designed the radio relay line RL-30.

1952

- Design of the radar complex "Kama" for stationary sites of Moscow defense S-25 and the microwave radio relay line “Tsepochka ".

1955

- Design of the radar altimeter “Konus” (PRV-10).

1956

- Design of the mobile radar P-30 as well as the two-co-ordinate mobile radar "Tropa" to detect low-flying targets. There were also designed ground based radar beacons NRZ-15, NRZ-20, NRZ-50 and NRZ-100.

1958

- Design of the radar P-35.

1961

- Design of the stationary three-coordinate radar “Pamir” (P-90) and the radar altimeter “Vershina” (PRV-11).

1962

- Design of the mobile radar complex “Altai” (P-80 and P-80A) for detection of air targets, targeting fighters and anti-aircraft missiles.

1975

- Design of the three-coordinate passive radar complex “Basa” with a short base.

1977

- The mobile radar of all-round surveillance “Mashuk” for detecting and tracking missiles and aerodynamic targets under difficult noise conditions.

1980

- The beginning of production of the three-coordinate mobile radar ST-68 for detecting and tracking low-altitude targets in presence of active and passive noise and reflections from the Earth's surface in bad weather.

1986

- Design of two-coordinate semiconductor radar “Casta-2” (35N6) for detecting low-flying targets.

1990

- Improved solid-state radar for detection of low-flying targets “Casta-2-2” (39N6).

1992

- Design of the three-coordinate radar of medium and high altitudes with phased-array in solid-state performance “Gamma-D”.

1997

- The mobile three-coordinate radar “Gamma-S1” for detection, guidance and targeting.

- The phased array was delivered to the South Korea to upgrade the anti-aircraft missile system.

1998

- Two radars “Casta-2E” were produced for Greece.

1999

- The beginning of the serial production of the radar “Gamma-C1”.

2001

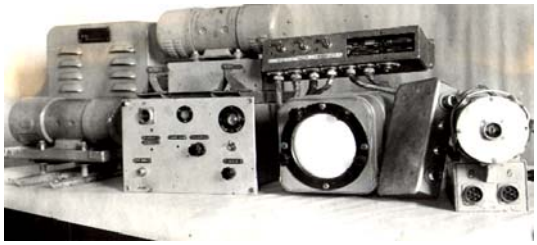
- Beginning of the navy phased array radar design.

2002

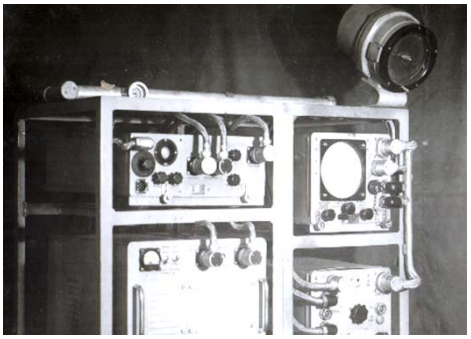
- There was finalized the design and made air test experiments of the solid-state radar with digital lobe forming “Panzyr-S1”

Radar RUS-2, 1939-1940

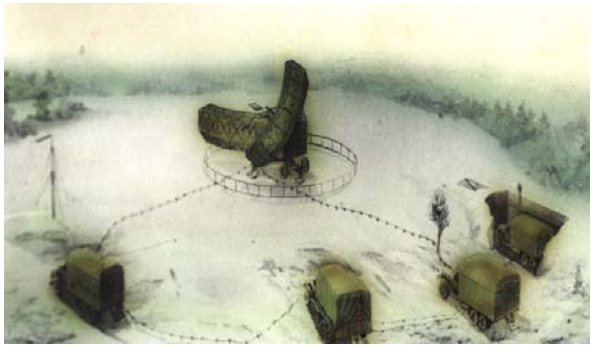
Radar P-3, 1944



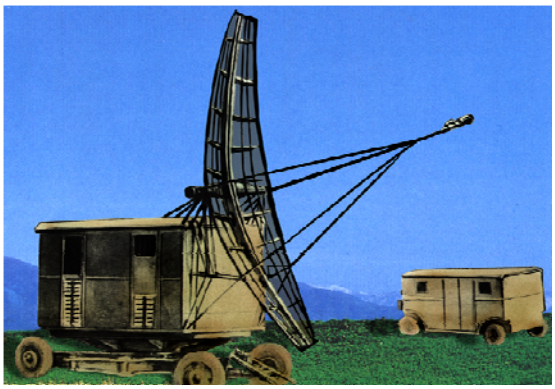
Airplane radar “Gneiss-2”, 1942



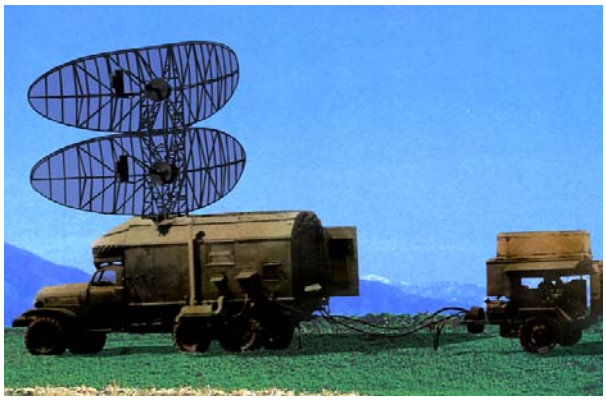
Naval radar “Gujs” – 1M, 1944



Radar P-20, 1949

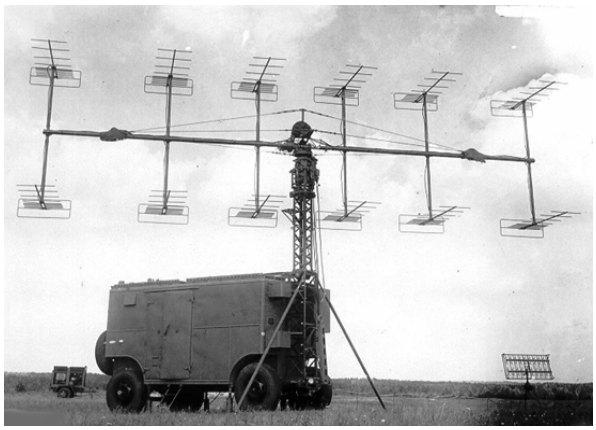


Radar PRV-10, 1955



Radar P-15, 1955

Radar P-90,1961



Radar P-12

Radar 64N6

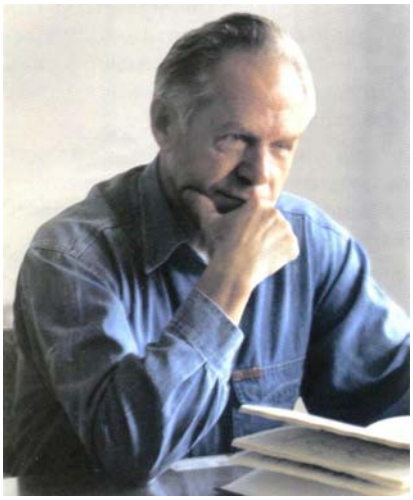
Radar “Gamma-D”, 1992

Radar for missile control 1RS1-1

M. RESHETNEV CORPORATION

"INFORMATION SATELLITE SYSTEMS"

Scientific Production Association of Applied Mechanics (since 2008 - JSC "Information Satellite Systems" named after Academician M.F. Reshetnev) is one of the major aerospace industry in Russia with the unique experience of creation and operation of space systems for communication, broadcasting, data transmission, navigation and geodesy.



M.F. Reshetnev (1924-1996)

Scientific Production Association of Applied Mechanics was organized in 1959 as the branch of the Moscow Special Design Office – 1 (now - Scientific Production Association "Energia") on site of Krasnoyarsk region (now – city Zheleznogorsk). The head and the chief designer of the branch was appointed PhD M.F. Reshetnev, later academician, Hero of Socialist Labor, Laureate of Lenin and State Prizes.

1962-1964

- Design of the missile-launchers 11K65, 11K65M ("Kosmos") to the orbit of satellites up to 1500-2000 km. By 1996 there were produced 300 missiles.

1962-1965

- Design of special experimental communication satellites 11F610 and 11F611. Launched 29 satellites.

1967

- Design of the communication satellites "Molnija-1" (launched 29 satellites).

- Design of the high-altitude sonde for Earth atmosphere sounding up to 4000 km and the navigation-communication satellite 11F617.

1968

- Design of the geodesic satellite “Sphera”. Launched, in all, 19 satellites.

1970

- Design of the satellites of special purpose 11F625 and 11F626.

1971

- Design of the coherent and television satellite “Molniya-2”. Launched, in all, 17 satellites.

1973

- Design of the communication satellite “Molniya-1B”.

1974

- The first in Russia geostationary satellites “Molniya-M1S” and “Raduga” were put on the orbit by the missile “Cosmos-637” as well as the communication satellite “Molniya-3”(launched, in all, 48 satellites) and the navigation and communication satellites 11F627 (launched, in all, 86 satellites).

1975

- Design of the communication satellite “Raduga”. Launched, in all, 32 satellites.

1976

- Design of the satellite for the direct broadcasting “Ekran” (in all, 17 satellites) and navigation satellites “Cicada” (in all, 12 satellites).

1978

- Design of the communication and television satellite “Horizon” for transmission of television programs, telephone and telegraph communications, communication ships with shore stations. Launched, in all, 31 satellites.

1981

- Design of the geodesic satellite “Geo-IK” to determine parameters of the gravitational field of the Earth, to affix coordinates and to study the topography of the oceans. Launched, in all 13, satellites.
- Design of the radio amateur satellite “Radio” (in all, 7 satellites).

1982

- Design of the communication satellite “Potok”. Launched nine satellites.
- Design of the satellite system COSPAS-SARSAT “Nadedzda”. Launched, in all, 11 satellites.
- Design and launching of the navigational satellite GLONASS. Launched, in all, 81 satellites.

1983

- Design of the communication satellite “Molniya-1T”. Launched, in all, 25 satellites.

1985

- Design of the communication satellite 17F13. Launched, in all, 102 satellites.
- Design of the satellite “Luch” to relay the information by manned spacecraft, to transmit television reportages of small stations, to use for telemedicine. Launched, in all, 4 satellites.

1987

- Design of the second-generation satellite for the direct television broadcasting “Ekran-M”. Launched, in all, three satellites.

1989

- Design of the passive geodetic satellite “Etalon” (in all, 2 satellites), television satellite “Raduga-1” (launched, in all, 3 satellites).

1992

- Design of e-mail satellite “Gonez-D”.

1994

- Design of the satellite for direct broadcasting “Gals”, satellite for a system of fixed communication “Express”, amateur satellite “Radio ROSTO”.

1995

- Design of the satellite to relay information data “Luch-2”.

1996

- Design of e-mail satellite “Gonez-D1”. Launched, in all, 6 satellites.

1997

- Design of the communication-navigational satellite “Zeya”.

1999

- Design of the communication satellite SESAT for the international organization EUTELSAT, advanced satellite system of fixed communication “Express-A”, experimental satellite PBSN-40.

2000-2002

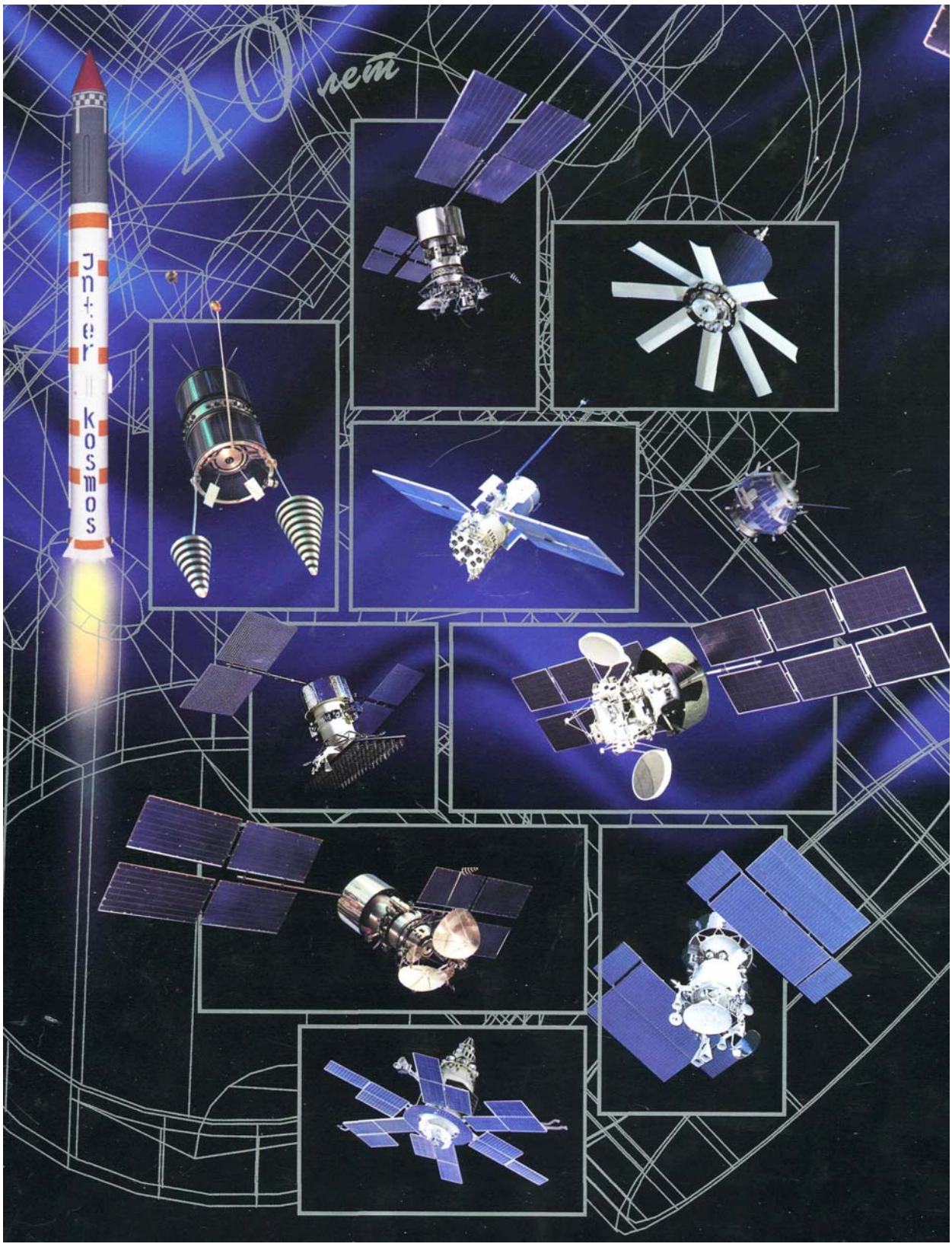
- Design of the satellite for the direct broadcasting of the second generation “Gals-R16”, satellite system of a new generation for fixed communication “Express-K”, the second generation navigational satellite “Glonass-M”, e-mail satellite “Gonez”.

View of the central part of the factory, city Zheleznogorsk

Communication and TV satellite "Molnija-3"

Navigation satellite GLONASS-K

Satellite antenna on the test bench



Together with subcontractors there were designed, manufactured and put onto orbit more than 1000 satellites of 30 modifications

JSC "RADAR MMS"
(ST-PETERBURG)

The company "Radar MMS", which has a 55-year history, specializes on the design and manufacture of military and civil avionics, special equipment, using microwave and digital technology, sophisticated software, microelectronic products. The company makes a large contribution to the creation and development of radio-electronic devices for mobile systems, precision weapons air-, sea- and land-based.

1950

- There was organized in Leningrad as a part of the factory No. 275 the special design office OKB-275 to bring up to series production and installation the systems for navigation and blind aircraft's landing . During the years 1950-1970 there were put into operation more than 155 systems.

1950-1970

- Design and production of ground-based systems of landing the aircrafts and of different kinds of measuring radio equipment – in all, 17 names. The head designer Ja.N. Faenson.

1955

- Design of the UHF radio direction-finder ARP-6.

1964

- The research project “Igla” with the goal to design an air radar of side-seeing with synthetic antenna aperture. The head designer N.P. Krasjuck.

1965

- Design of a high resolution radar “Raskat” for ship’s navigation - M. Dubrovsky, J.N. Gryaznov

Design manager Ja.N. Faenson

Design manager M.I. Dubrovsky

Design manager G.S. Isserlin

Design manager V.G. Elfimov

1966

- The special design office OKB-275 became an independent body “Leningrad design office “Zarnitsa”

1967

- The project “Toros” with the goal to design radars in order to equip the aircrafts of ice reconnaissance - AN-24.

V.M. *Glushkov, design manager, laureate of the Stalin and the State Prizes*

V.A. Potekhin, director of the Institute of Radio Electronic Systems

AB Poznansky design manager of the active target seekers

G.V. Antsev general director and chief designer of the JSC "Radar MMS"

1969

- G.I. Sokolov, A.A. Hussar, N.G. Artamonov and I.G. Chenet designed 13-channel instrumentation for magnetic recording and playback - "Phasa-13".

1972

- Leningrad design office "Zarnitsa" became a part of the All-Russia Research Institute of Radio Electronic Systems (further we would call it Corporation "Leninets"). The main goal of research became radars.

1973

- The test bed "Lepestok" for automated recording antenna patterns there was designed by V.V. Markov

1963-1988

- Design of the ground-based automated control systems of aircraft's control: "Gotovnost" - L.Ja. Shalyt, "Pluton" - Ja.B. Golovich, "Don" - V.Z. Lugovoj, "Uran-T" - N.G. Artamonov.

1975-1980

- Design and production of on-board automated control systems for the aircraft AN-124 (G.S. Isserlin).

1975

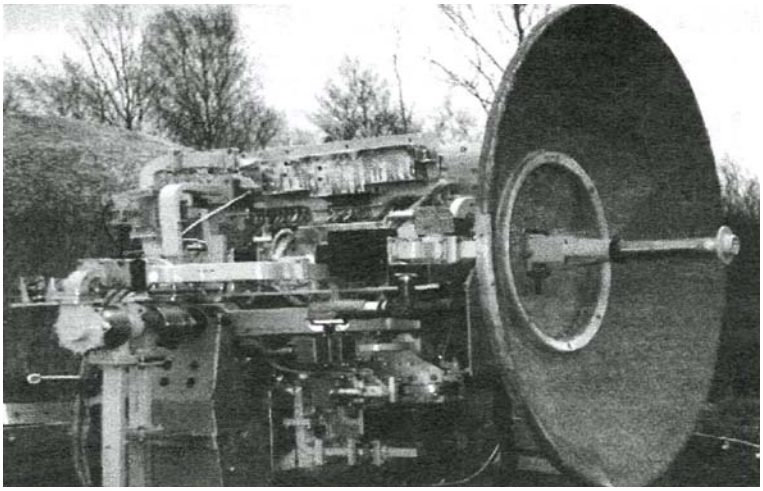
- The synthetic aperture radar "Igla-1" was widely exploited by the aircrafts IL-20.

1981

- Design, manufacture and testing of the synthetic aperture radar for taking radar pictures of the Earth surface with different polarization of the sounding signal.

1984

- The first sample of the active radar seeker ARGS-35 for the anti-ship missile X-35.



Antenna-waveguide polarization radar, 1980

Active radar seeker ARGS-35E

1985

- Beginning of design of the multifunctional self-directing missiles U-502 (A.B. Poznansky).

1993

- Design and manufacture of two-frequency (2 cm and 2 m) airborne SAR of a new generation “Iceberg-Razrez” with digital signal processing (V.G. Elfimov)

2003

- State tests of the upgraded radar seeker ARGS-35E for anti-ship missile X-35E as a part of the complex “Uran-E”.

Start of the anti-ship missile X-35E with a radar seeker ARGS-35E made by JSC "Radar MMS", 2002

CORPORATION “PHAZOTRON-NIIR” (MOSCOW)

Open Joint Stock Company “Corporation “Phazotron-NIIR” is the first enterprise in Russian avionics – the leader of the design and manufacturer of radars and radar control systems of weapons of various types of aircraft and helicopters, as well as ground-based air defense systems, means of displaying information about the status of systems of spacecraft and astronauts, meteorological radars and civilian products.

A.I. Kanaschenkov

From 1985 to 2007, the corporation “Phazotron-NIIR” was directed by A.I. Kanaschenkov, DSci, the State Prize laureate, a member of three international academies.

1917

- Birth of the plant “Aviapribor”.

1933

- Converting the plant to “Tizpribor” meant to produce thermal equipment.

1943

- Beginning of production of the radar “Pegmatit” and airborne responders SCh-1, 3.

1955

- The beginning of production of the radar “Sokol” for the plane YaK-25.

60-ies.

- Equipment “Strelka”, “Symvol” and their variations intended to display information about the status of systems of spacecraft and astronauts, as well as for manual docking of spacecraft on the orbit.

1961

- The radar “Orel” was taken by the Army for the airplane YaK-28.

1965

- The radar “Orel” was taken by the Army for the airplane SU-15.
- The radar “Smerch” was used in the airplane TU-128.

1969

- There was organized the research and design association “Fazotron”.

1972

- The radar “Smerch-A2” was used in the airplane MIG-25 P.
- The radar “Sapphire-21” was used in the airplane MIG-21 BIS.

1973

- The zenithal complex “Cub-M1” was accepted by the Army.

1974

- The airplane MiG-23 was equipped with the radar “Sapphir-23”.

1975

- The airplane SU-15 was equipped with the radar “Taifun-M”.

1979

- The zenithal complex “Cub-M3” was accepted by the Army.

1980

- The airplane MiG-25 was equipped with the radar “Sapphir-25”.

1981

- The airplane MiG-31 was equipped with the radar “SUV-31”.

1987

- The airplane MiG-29 was equipped with the radar “SUV-29”.

1990

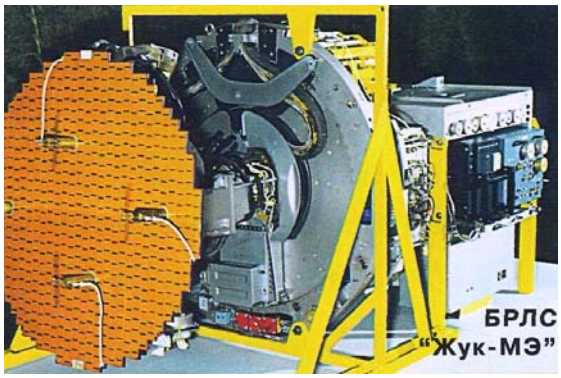
- The airplane SU-27 was equipped with the radar “SUV-27”.

1993

- Production of the airplane MIG-29-93 with the radar “Kopje”.

1997

- Beginning of active work on the creation of a new generation of airborne radar with slotted phased array antennas of X-band. The gain of the antenna was about 29-36 dB.



Airborne phased array radar

1998-2003

- Design of medical devices: low-frequency magnetic therapy (1998), the device with the joint effect of pulsed low frequency magnetic field and the electric current (2001), etc.

1999

- Design of meteorological radar "GUKOL-1" with phased array.

2000

- Beginning of the design of the aerospace radar system for monitoring the Earth's surface.

2000

- The beginning of mass production of the radar "Kopje" for the airplane MIG-21 Bis UPG.

2000

- Beginning of the radar for monitoring the Earth's surface with ultra-high resolution design (up to 1-3 m in X-band).

2001

- End of testing the radar "Zhuk" in the aircraft F-8-P.

2003

- Production of portable thermoelectric ecologically clean refrigerator "Fazoterm" (without Freon).

Avionics production of the Corporation "Fazotron"

Avionics production of the Corporation "Fazotron"

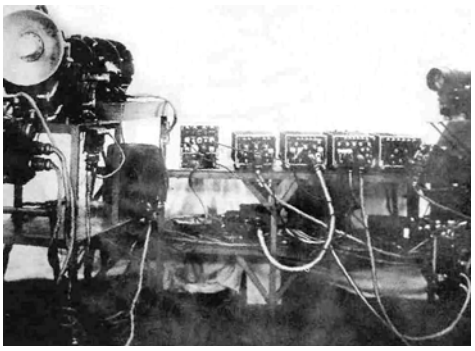
CENTRAL DESIGN OFFICE OF AUTOMATION

(OMSK)

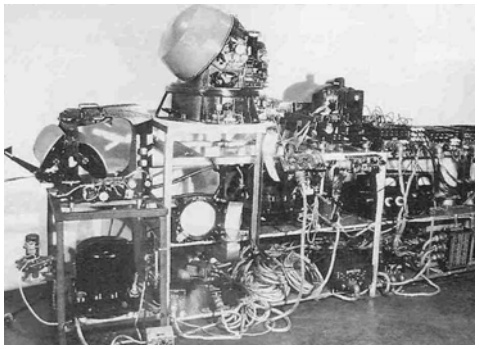
The Central Design Bureau of Automation (CDBA) is the leading Russian enterprise in the development of passive radio-electronic systems, direction finding, targeting and homing to the Air Force, one of the Russian and world leaders in the development of radio systems for various applications for military aircrafts. Products of CDBA are used in 26 types of aircrafts and 18 types of missiles.

1949

- In the Siberian city Omsk there was organized the plant № 373 of Ministry of Aviation Industry of the USSR.



Radar sight PRS-1 on the test bed



Radar 3DK

1952

- Refinement and upgrading of the radar sight PRS-1 for the conduct of cannon fire in the rear hemisphere of TU-16 TU-95, M4 and Chinese H-6 aircrafts.

1956

- Design of the radar sight PRS-2 to equip strategic bombers TU-95 (the leader I.V. Kudryavtsev). Flight test of a compact radar sight PRS-3.

1958

- Design of 3DK – the radar for detection, aiming and control of gun armament to equip a torpedo boat (the leader A. Zaitsev).

1959

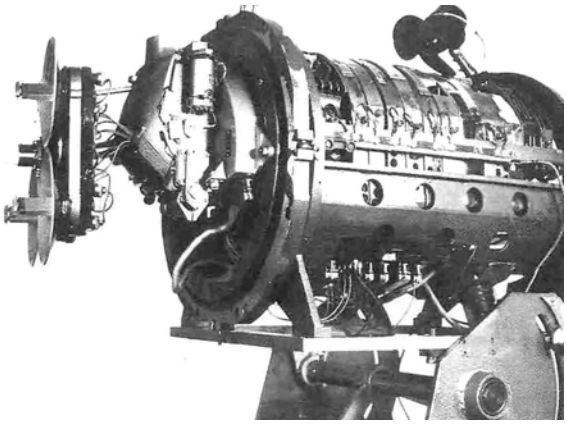
- Flight tests of a new generation of the radar sight PRS-4 for the airplanes TU-16, TU-95K and AN-12. Series production began in 1962.
- The airborne warning radar station signaling about irradiation SPO-3 was accepted by the Army.

1962

- Design in cooperation with RIRE the station of radio intelligence K12M (the leader M. D. Dgavoronkov – State Prize).

1964

- Design of a passive anti-radar homing head PRGS-28 to control the airplane missile X-28 with a circular probable deviation from the target of 20 meters (the chief designer A. Kirichuk - State Prize, 1977).



Homing head PRGS-28A

1967

- Design of a passive system “Kurs-H” for direction-finding and providing information for missiles X-22P of the class air-to-surface.

1968

- Flight tests of the passive radar “Filin-N” (the chief designer V.P. Fedorov). In 1980 he invented a container option – “Phantasmagoria”, in 1988 - a modernized version “Ethnographia”.

1973

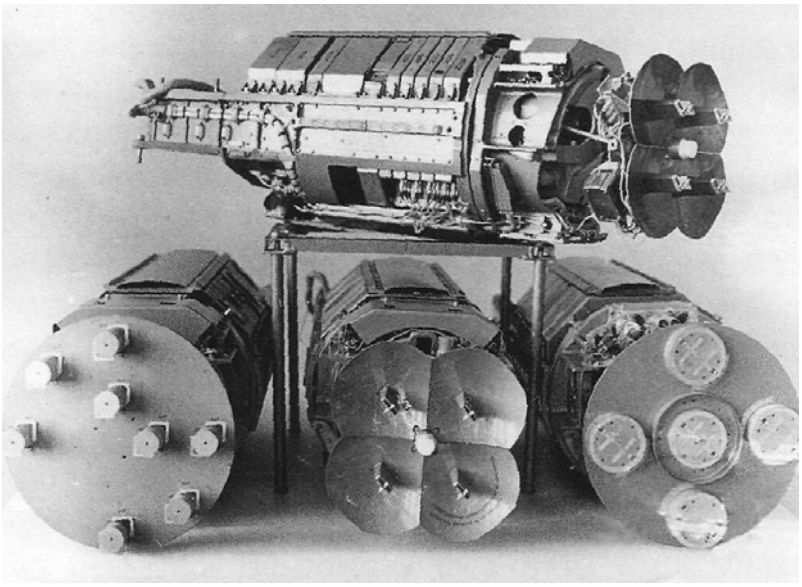
- Flight tests of the airborne warning radar station signaling about irradiation SPO-15. From 1987 the station was manufactured in digital design.
- Design of a system of targeting “Metel” for the missile X-28.

1974

- Design of a homing head PRGS-58 for airplane anti-radar missile X-58. (Chief designers V.G. Archangelsky and B.A. Guselnikov).

1978

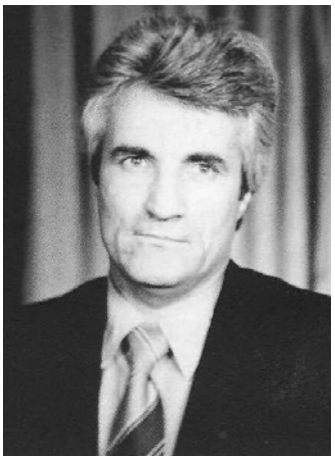
- Design of a small-sized homing head PRGS-2VP for the missile X-25MP (Chief designer B.G. Zaitsev).
- Design of a system of targeting "Vjuga" for the missiles X-58 and X-25MP.



Homing heads PRGS-58

V.G. Archangelsky

Missile X-58E



B.A. Guselnikov

1979

- Design of a homing head 9N-215 for missiles of class “surface-to-surface” (Chief designers V.P. Zaitsev and A.A. Vorobiev).

1980

- Design of the passive radar corrector PRK-15 for air-ballistic hypersonic missile X-15 (Chief designer N.E. Potocki).

1983

- Design of the modular station of new generation warning about irradiation “Pastel” to equip a wide range of aircrafts.

1985

- Design of the unified targeting apparatus "Progress" for the airplanes MIG-23, MIG-27 and SU-17.

1986

- State tests of the anti-radar homing head 9B-1032 for the missile R-27 and aircrafts MIG-29, SU-27 and SU-33.

1987

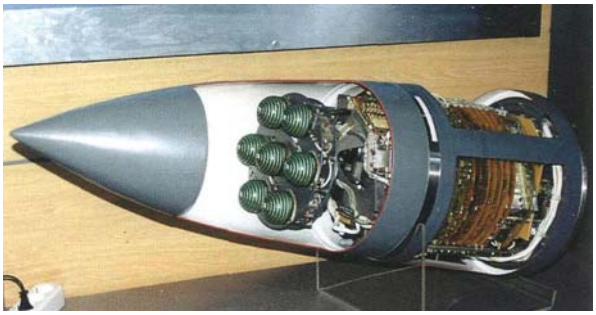
- Flight tests of a new anti-radar missiles with a homing head PRGS-5VP and state tests of the head PRGS-6VP (Chief designer B.G. Zaitsev).
- Design of checkout equipment Sh-301 for a system of electronic intelligence settable at the aircraft AN-70.

1994

- Design of checkout equipment A-149 for the station warning about irradiation “Pastel”.

2000

- Start of export deliveries of the modernized sample of homing head PRGS-5VP.



Passive radar homing head PRGS-5VP

2004

- Design and export of apparatus SKPA for checking the passive homing heads.

From 1982

- Design and manufacture of devices and systems of national economic purpose: stereo equalizers; medical devices; meters of liquid flow, gas, oil, etc; the system "Geosiemka" to estimate co-ordinates; television transmitting apparatus of low power "Radius" to relay satellite TV programs.

SOURCES OF INFORMATION

1. V.A. Sarytchev, Development of the means of electronics, informatics and management technology used at the transport, *Problems of transport*, 2000, iss. 3. (In Russian)
2. B.A. Vvedensky, *Microwave Propagation*, Moscow, Nauka, 1973. (In Russian)
3. Short chronology of radio. [Online]. Available: http://www.viol.uz/chronicle.html (In Russian)
4. History of the electrical spark. [Online]. Available: http://radiomuseum.ur.ru/index5.html (In Russian)
5. L.I. Sharygina, *Radio Electronics Chronology*, Tomsk, TUCSR, 2010. (In Russian)
6. "New" history: communication and optic systems. [Online]. Available: http://www.nioltele.com/histiry1.htm (In Russian)
7. Radio…radio…radio…(the beginning of the XX century). [Online]. Available: http://www.rirt.ru/history/navigation/xx-century.htm (In Russian)
8. Invention of a telegraph without wires system by A.S. Popov. [Online]. Available: http://physfac.bspu.secna.ru/journals/physics/2002/16/no16_1.htm (In Russian)
9. V.M. Pestrikov, History of the transmitter: design and authors. *Radiohobby*, 1999, N1, pp.2-4. (In Russian)
10. V.A. Melnik, D.F. Kondakov, Chronology of the national radio engineering and broadcasting. [Online]. Available: http://www.qrz.ru/articles/detail.phtml?id=63 (In Russian)
11. Calendar of the outstanding events in electronics and communication. [Online]. Available: http://u887.24.spylog.com/cnt?f=3&p=1&rn=0.4040503111535495 (In Russian)
12. B.A. Vvedensky, M.A. Kolosov, A.I. Kalinin and Ja.S. Shifrin, *Far Troposphere Propagation of the Microwaves.* Moscow, Sovetskoe Radio, *1965.* (In Russian)
13. New history. Calendar of events. [Online]. Available: http://www.computer-museum.ru/connect/calendar.htm (In Russian)
14. Cookk K.I. Communication in the Great Patriotic war. [Online]. Available: http://www.computer-museum.ru/connect/radio_vo.htm (In Russian)
15. History of television. [Online]. Available: http://www.internews.ru/tvhistory/l/19.html (In Russian)

16. Some dates in the exploration of the magnetosphere. [Online]. Available: http://www.ikj.rssi.ru/mirrors/stern/Education/whchron.html (In Russian)
17. New history: communication and optic systems. [Online]. Available: http://www.nioltele.com/history1.htm (In Russian)
18. CBN History: Radio/Broadcasting Timeline. [Online]. Available: http://www.wcbn.org/history/wcbntime.html (In Russian)
19. W.A. Fock, *Problems of Diffraction and Electromagnetic Waves Propagation*, Moscow, Sovetskoe Radio, 1970. (In Russian)
20. G.S. Sharygin, Statistical Structure of the Microwave Field over the Horizon. Moscow, Radio i Svjaz, 1983. - In Russian
21. G.S. Sharygin (editor), Troposphere Radioclimatic Atlas of the Pacific Ocean, Tomsk, TUCSR, 2000.
22. http://www.prazdnik.by/holidays/inter/nov/21nov_television
23. History of digital television. [Online]. Available: http://www.dtb.ru/news/tv.php (In Russian)
24. Mary Bellis, History of Television. [Online]. Available: http://inventors.about.com/library/inventors/bltelevision.htm
25. TV Broadcasting. The development of mass-media visual broadcasting and the inventions that led to its popularity. [Online]. Available: http://www.historymole.com/cgi-bin/main/results.pl?type=theme&theme=TV
26. History-television. Important dates in the history of television. [Online]. Available: http://www.dennisglass.com/history-tl-television.html
27. M.E. Rovkin, Ju.P. Akulinichev, M.P. Kozlov, Software for Field Characteristics Calculation Using Measured Refraction Index High Profile. *Proc. of the Russian science conf. "Physics of the Radio Waves"*, Tomsk, vol. 1, 2002, pp. 44-46. (In Russian)
28. Ju.A. Khramov, *Physicists. Biographies,* Moscow, Nauka, 1983, 400 p. (In Russian)
29. Saveliev, Phantazy and reality. *Secrets of the XX century*, 2008, No. 45, pp. 28-29. (In Russian)
30. V.N. Troitskii, Microwave Propagation in Mountains. Moscow: Svjaz, 1968. (In Russian)
31. V.N. Troitskii, Diffraction of the Microwaves at Mountain Ranges, in articles collection "*Radio Waves Propagation*", Moscow, Nauka, 1975, pp. 154-186. (In Russian)
32. Digital Audio Radio Service (DARS). [Online]. Available: http://history.sandiego.edu/gen/recording/dars.html
33. M. Liotcy *History of physics,* Moscow, Mir, 1970, 464 p. (In Russian)
34. P.S. Kudrjavtsev, *Course of the physic's history*, Moscow, Prosvetsenie, 1982, 448 p. (In Russian)
35. B. Yenne, *100 Inventions that Shaped World History***,** Bluewood Books, 1993.

36. Asimov, *Asimov's Biographical Encyclopedia of Science and Technology,* New York, Doubleday & Company, Inc., Garden City, 1982.
37. J. Greenfield, *Television, the First Fifty Years*, New York, Harry N. Abrams, Inc., 1977.
38. P.K. Gorokhov, *B.L. Rosing – the father of the electronic television,* Moscow, Nauka, 1964. (In Russian)
39. History of Photography. [Online]. Available: http://www.sepia.me.uk/history/1900.htm - in Russian
40. *Soviet encyclopedic dictionary,* Moscow, Soviet encyclopedia, 1984. (In Russian)
41. Short radio chronology. [Online]. Available: http://www.viol.uz/chronicle.html (In Russian)
42. Historical Perspectives of Microwave Technology, *IEEE Transactions on Microwave Theory and Techniques*, 1984, Vol. 9.
43. History of the Computer. [Online]. Available: http://www2.fhtesslingen.de/telehistory/comp30.html
44. С. Бережной, Фантастика в XIX веке: американский вклад. http://barros.rusf.ru/article137.html
45. *Reference book of a radioamateur*. Moscow-Leningrad, 1951. (In Russian)
46. A. Minz, Soviet radio engineering during 35 years, *Radio*, No. 11, 1952, pp. 4-9. (In Russian)
47. Chronology of the soviet radio broadcasting, *Radio*, 1977, No. 7, pp. 2-5; No. 8, pp. 4-6; No. 9, pp. 6-7, 25; No. 11, p. 16. (In Russian)
48. From the Popov's radio to the modern electronics, *Radioegegodnik-85*, Moscow, 1985, pp. 6-22. (In Russian)
49. Broadcasting during the Great Patriotic war, *Radioegegodnik-88*, Moscow, 1988, pp. 7-15. (In Russian)
50. V.M. Pestrikov, In the fight with the space and time (about A.S. Popov and G. Marcony), *Radiolyubitel*, 1993, No. 9-10, pp. 5-6. (In Russian)
51. V.M. Pestrikov, Radioreciever – the world of beauty (devoted to the 100 anniversary of radio), *Radiolyubitel*, 1995, No. 5, pp. 2-3. (In Russian)
52. V.M. Pestrikov, Successor of A.S. Popov – a friend of G. Marcony. *Radiohobby*, 1999, No. 4, pp. 2-3. (In Russian)
53. National lamp radio devices. Reference book (2000). [Online]. Available: http://www.q!"z.ru/articles/detail.nhtml?id:=63 (in Russian)
54. *Electrician*, 26 Oct. 1990, v. 46, p. 21.
55. N.V. Dunaevskaja, V.A. Urvalov, M.G. Sculman, From the history of magnetic video recording, *Electrosvjaz*, 1999, No. 12; also [Online]. Available: http://www.computer-museum.ru/connect/tvrechis.htm (In Russian)
56. Stages of radar's development (historical information), 2004, [Online]. Available: http://www.q!"z.ru/articles/detail.nhtml?id:=63

57. *Fourth space years. Memoirs about development of the rocket-space activity of the firm. Zheleznogorsk firm named after M.F. Reshetnev*, 1999, 312 p. (In Russian)
58. *On the way of progress – to the new achievements,* St.-Petersburg, "Radar", 2006, 440 p. (In Russian)
59. *"Phazotron" – from the XX century to the XXI*, Moscow, 2000. (In Russian)
60. *The Central design office of automation – 55 years on duty,* Moscow, 2004, 152 p.