Optical Telegraphy in Russia: 1794-1854

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***Abstract* — The article examines the history of optical telegraphy in Russia and describes some main projects of Russian inventors.**

***Index Terms* — Optical telegraphy, Claude Chappe, Abraham Edelcrantz, Agustín Betancourt, Ivan Kulibin, Alexander Butakov, Pavel Chistyakov, Piotr Kozen, Pierre-Jaques Chatau.**

I. The Beginning of Optical Telegraphy

By the end of XVIIIth century in the leading European countries the need for the systems of message transmission on the long distances was felt. The optical telegraphy became the base on which first nationwide telecommunication networks were constructed. It determines the significance of this technology in the history of telecommunications.

The first optical telegraph line between Lille and Paris was set in France during the Great Revolution in 1794 by Claude Chappe (1763-1805) (Fig. 1). It length was 230 km. The very first successful communication – the message about seizure of Conde which was delivered to Paris only for 15 minutes – greatly impressed the public [1, 2].

Figure 1. Claude Chappe.

For signal transmission Chappe used special semaphore consisted from long 4 meter arms which rotating on the pin could take one of four positions: vertical, horizontal, and two sides oblique. The shorter 1 meter arms were attached to the both ends of long one. Each of them could take one of eight positions relative to the long arm thus generating 196 various signals in total. Telegraph stations were set on uplands in the towers (Fig. 2) which were located on 10-28 km apart. Signals were observed by telescopes.

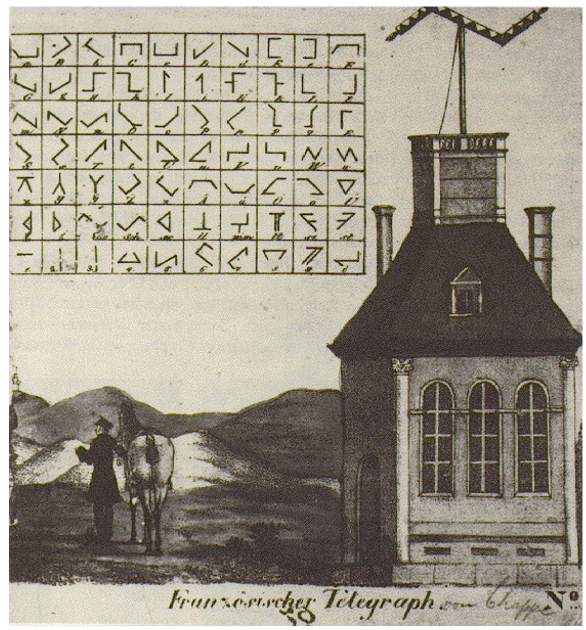

Figure 2. Tower and the table of signals of Chappe telegraph.

In France Chappe telegraph was widely used. To the 1844 the total length of lines with 534 stations was 5000 km. The optical line connected 29 cities [3, p. 63].

Chappe′s invention was the signal to the appearance of optical telegraph in other countries. It seems strange but these countries used another original message transmission systems not Chappe one.

Sweden was the first after France country in which the telegraph network was established [4]. Telegraph invented by Abraham Niclas Edelcrantz (1754-1821) was based not on changing of lath positions but on opening and closing of 10 shutters on special windows (Fig. 3). To the 1809 telegraph lines connected Stockholm with cities on the north, south and east. Total length of the lines was 200 km and about 50 stations worked. Danish marine officer Lorenz Fisker (1753-1819) modified Edelcrantz system in 1799: instead of ten shutters, his device had 18 rotating flaps (each 2×0.75 m). At the beginning of year 1801 24 stations along coast line were built, but were discarded to the end of the year [5].

The building of another Danish line began in 1808. In this year the building of the first telegraph line in Norway also started.

Figure 3. Edelcrantz′ telegraph station.

In England the first optical telegraph line designed by George Murray (1761-1803) was opened between London and Deal on the end of January 1796. The idea of Murray project was borrowed from Edelcrantz but it had only 6 octoganal shutters (Fig. 4) [6]. However, several lines (65 stations) were built to the beginning of 1808. They were actively used till 1816 when were replaced by the telegraph of the system of Admiral Home Riggs Popham (1762-1820) [5].

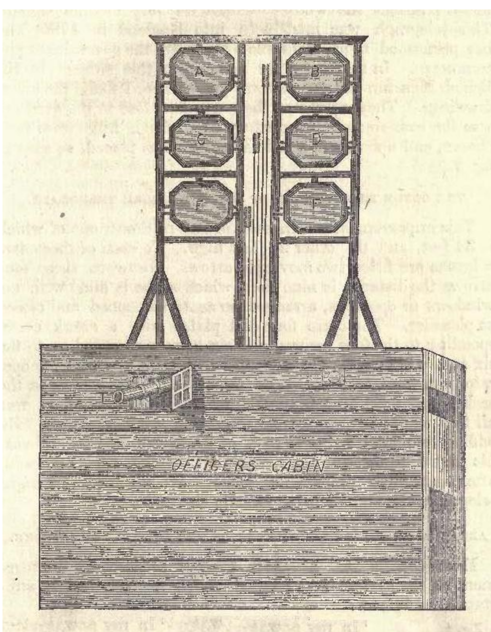

Figure 4. Murray′s telegraph station, England.

Circa 1798 telegraph was erected in some parts of Germany (Fig. 5). One more telegraph line between Madrid and Cadiz was built in Spain according to the original project of the outstanding engineer Agustín de Betancourt y Molina (1758-1824) with the help of famous French watchmaker Abraham-Louis Bréguet (1747-1823) in 1799-1800 (Fig. 6).

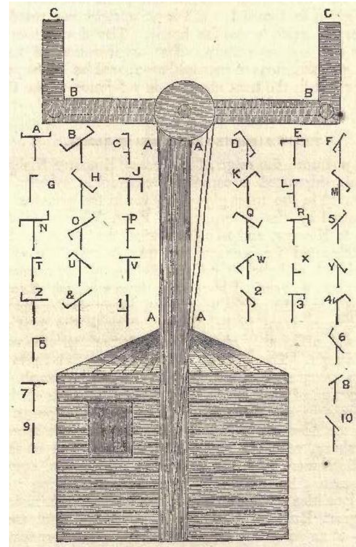

Figure 5. German telegraph station, c1798.

Later telegraph lines were built in Netherlands, Australia, USA, Prussia and other countries, including India (line between Calcutta and Chunore fortress, 1823), Egypt (between Alexandria and Cairo, 1824), Algeria (after 1844) and so on.

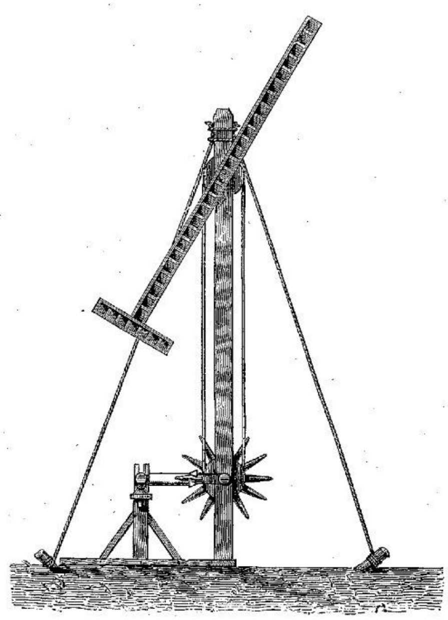

Figure 6. Spanish telegraph of Betancourt and Bréguet.

In Russia the Chappe′s invention became known in 1795 when in Moscow the anonymous brochure "Exact and detailed description of telegraph or newly invented long-distant transmission machine which can deliver and receive reports from the most remote places" [7] was published. It seemed that the Russian government would pay attention to the new method of message transmission which advantages were obvious for the military and governmental purposes. For the Russia with its tremendous lands telegraph presented the extraordinary importance. However, the efforts of Russian inventors did not find the official support.

II. THE FIRST RUSSIAN PROJECTS

Ivan Kulibin. The first Russian project of optical telegraph belongs to the remarkable mechanic and designer Ivan Kulibin (1735-1818). From 1796 till 1801 Kulibin (Fig. 7) was a director of workshops of Academy of Science in St. Petersburg and designed many original devices and mechanisms [8, 9].

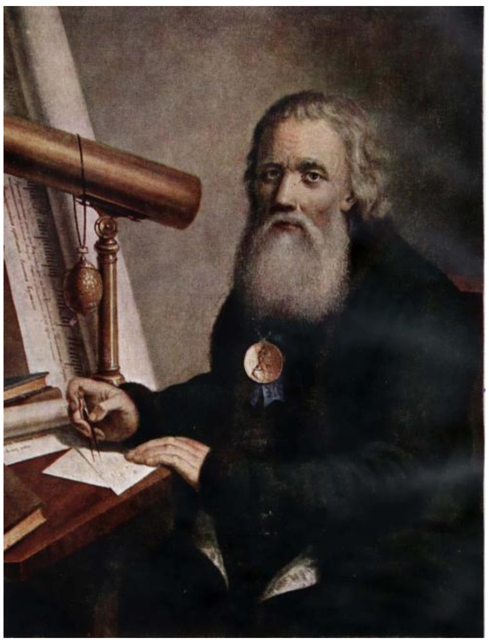

Figure 7. Ivan Kulibin.

It could be supposed that Kulibin learned about Chappe telegraph from the newspapers. At the end of 1794 he began the development of technical drawings. The handwritten note "Telegraph" in which the designer described the concept and construction of his own invention was found in his archive [8]. Above this, several other notes with instructions on model manufacture remained. The model itself was manufactured probably in 1795.

Principle of signalization Kulibin borrowed from Chappe. For the combination of telegraph signals he also used the construction from 3 arms: one was long and two were short (Fig. 8). Arm had the drive mechanism which gave the opportunity to get various arm positions (it worth to mention that Kulibin′s drive mechanism was simpler that Chappe′s one). For the better observation the mast with arms must be installed on the roof of high building or specially built tower. Towers must be built on determined distance from each other on full length from transmitting till to receiving point.

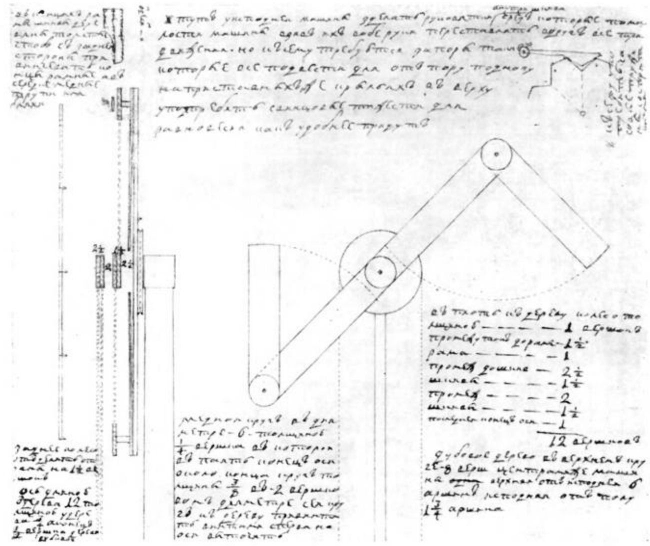

Figure 8. Drawing by Ivan Kulibin (c1794).

Telegraph code was designed on another than Chappe′s principles giving the opportunity to significantly faster transmission (Fig. 9).

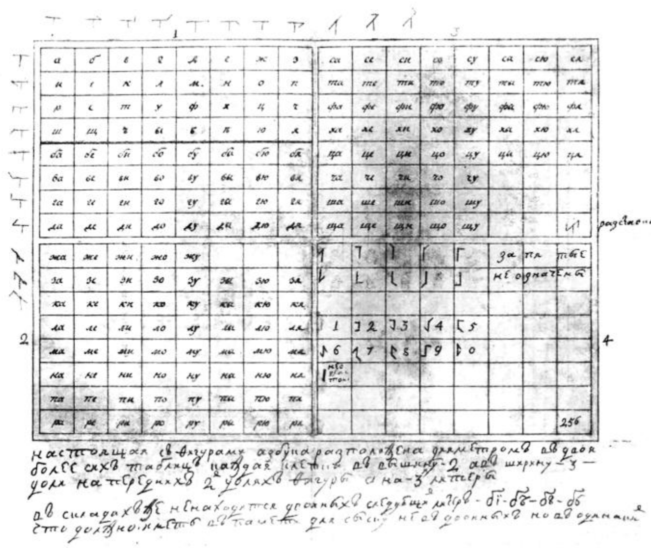

Figure 9. The table of telegraph signals of Ivan Kulibin (c1794).

Every arm position corresponded to the appropriate letter, figure or syllable. Kulibin′s telegraph code determined what words or phrases correspond to the transmitting letter of figure. The code was designed by Kulibin himself and in this he moved further than Chappe. The transmission of the words he did by parts dividing them on one-valued and two-valued syllables. Such a method takes it place between "alphabetical" and "numerical" methods and it is clear if the project of telegraph would have been adopted Kulibin improved the code. Telegraph also would have been improved. But in any case the manufactured model and code proves the originality of Kulibin system.

But nobody interested seriously in Kulibin project. Model was presented to the Empress Catherine the Great and she liked it. She praised Kulibin but ordered to send the model and drawings to Kunstkamera, the first museum in Russia. Emperor Pavel I remembered about the telegraph and on 11 January 1801 the model was delivered to him. Probably his interest could have the practical consequences but emperor was killed by conspirators two months later. Model was returned to Kunstkamera where it was stored 30 years until 1830 when transferred to the Navy Ministry.

Surveyor Ponyukhaev. In 1815 surveyor Ponyukhaev (his biography is unknown) invented "night fast long-distance writer or telegraph on seven lanterns, which can faster than other daylight telegraphs deliver data" [10, p. 223].

Every Ponyukhaev′s telegraph set consisted of seven lanterns, six of which were located on perimeter and one more – in center of the circumference (Fig. 10). The light was reflected by concaved mirrors and each lantern could be closed by movable shield. From the control post the shields could be opened and closed by means of rods thus getting various combinations of light lanterns. These combinations formed the code organized in special table.

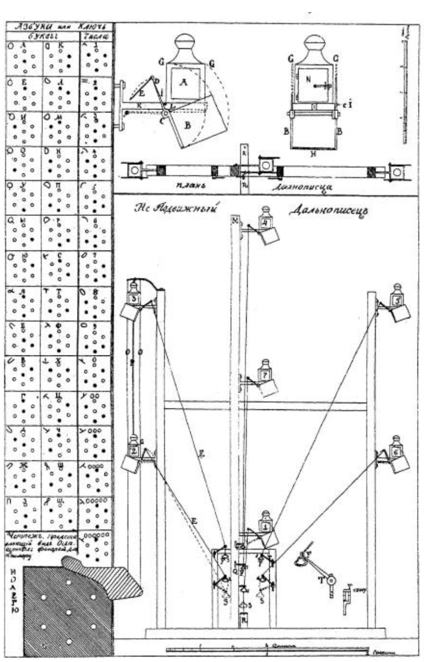

Figure 10. Telegraph of surveyor Ponyukhaev.

Operator at receiving station watched in telescope to the transmitting station and wrote the messages by pencil for the further decoding. As the advantage of his telegraph inventor mentioned the high velocity of message transmission – about half a second for the symbol change.

Telegraph posts must be located on 40 kilometers and even more apart depending of relief. Ponyukhaev suggested to make not only stationary bur also mobile posts: "Long-distance writer could be folding and iron made". It could be transported on horse carts. It was foreseen to use the "writer" in daylight as well.

Ponyukhaev′s long-distance writer was very original invention. It efficiently differed from previous constructions by simplicity and possibility to get mobile telegraph stations.

Ponyukhaev considered that his night fast long-distance writer in first turn would find application in army but Military Science Committee investigated the invention and took decision to hand it over to archive of Military Ministry.

Alexander Butakov. Alexander Butakov (1779-1845) was the representative of well-known family who gave the Russia only in XIX century 17 officers and admirals. Butakov himself retired as major general.

When sixteen years old Butakov became naval cadet and took part in the cruise of Russian Squadron for the blockade of Holland coast. In 1800 he as a lieutenant was in command of military transport and two years later he became a commander of frigate. In 1803 he was sent for the service abroad. As a volunteer of Britain fleet Butakov sailed in North Sea and Atlantic Ocean, visited West India. He participated in capture of slave ships and in 1805 took part in famous Battle of Trafalgar.

Butakov used the experience of his service in Britain fleet for developing the first Russian naval telegraph. This work took more than 10 years and the description of telegraph was published in 1817 [11]. The basis of Butakov signal system was the 14 sheave blocks installed on the common axis. These blocks were raised on mizzen mast yard. Another 14 sheave blocks for rotation were set in special box on the deck. Signal flags were attached to block halyards. These flags could be raised and downed by rotation of lower block special handles. Butakov′s telegraph was approved by Navy Ministry and recommended to the fleet.

Fifteen years later Butakov suggested another optical telegraph of very simple construction which could be used in countryside for the message transmission between estates (Fig. 11).

Figure 11. Title page of Alexander Butakov brochure [12].

Butakov wrote: "Its construction is simple, cheap and very convenient. On the height which can be observed from the neighborhood the pole is installed with the block on the top. There is the rope of little finger thick across the block by means of which 32 figures consisted of variously combined balls, flags and pennants are raised. These 32 figures mean 32 letters of Russian alphabet. In the village flags and pennants easily could be sewed from the canvas, coloured by some paint because the white colour is not clearly seen at any time. The balls are made from two hoops installed perpendicular to each other and covered by black canvas. This is the telegraph mechanism" [12, p. 5-6].

Signals of Butakov telegraph are shown on Fig. 12.

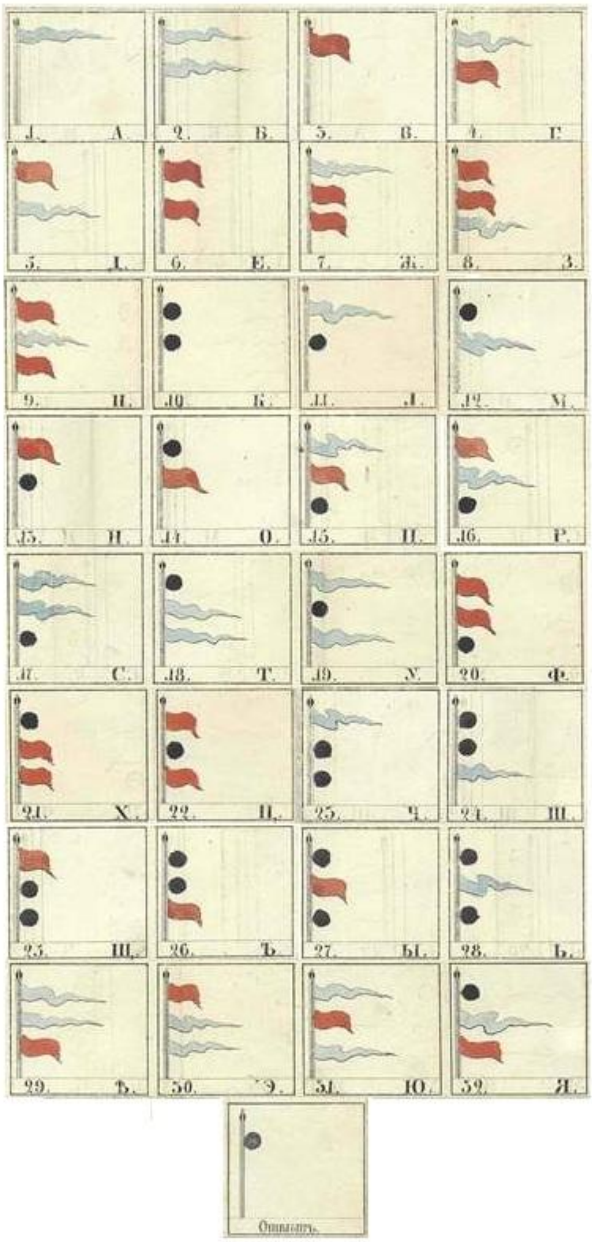

Figure 12. Telegraph of Alexander Butakov.

Pavel Chistyakov. Well known Russian naval commander Rear Admiral Pavel Chistyakov (1789-1851) from 1804 till 1819 sailed in Russian and foreign seas, took part in many battles and cruises. Than from 1819 till 1827 he taught at Navigation School. Probably combination of cruise experience and teaching brought him to the idea of design the mobile marching telegraph for the army. Chistyakov telegraph (Fig. 13) consisted of three wooden poles. Each pole had two rotating wings on common shaft. Combination of wings coded this or another signal. Telegraph could be used in night time – for this purpose the light lanterns were suspended on the wing tips.

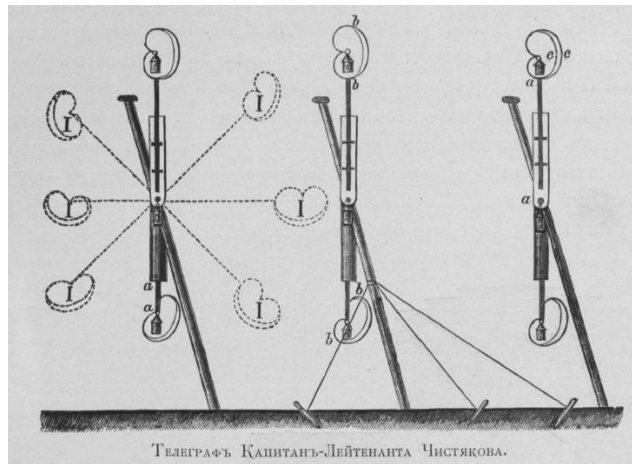

Figure 13. Telegraph of Pavel Chistyakov.

The experiments conducted were successful. Emperor Nicholas I personally saw these experiments and favored Lieutenant Commander Chistyakov by audience and awarded him by ring with brilliant [13, p. 128].

However this invention was not found the application in army. Only 12 years later in 1840 another attempt was made to use the Chistyakov telegraph stored on military depots for the needs of the fleet. Chistyakov (who at that time was rear admiral) addressed to the Submarine Committee the detailed note in which he explained how on the base of telegraph poles one could built the system signalizing the necessity of explosion when enemy ship is moving over underwater mines. But this suggestion was not realized as well.

Piotr Kozen. Piotr Kozen (1776-1853) was really bright person and brave officer. He took part in all campaigns of Napoleon′s war era: in 1812 he fought near Vitebsk and Smolensk, at Borodino, participated in attacks near Tarutino and Maloyaroslavets. During foreign campaigns he took part in the battles of Drezden, Bauzen, and Battle of the Nations near Leipzig and ended the war in Paris. For his military valour Kozen was decorated by more than ten orders of Russia, Prussia, Austria, Bavaria and other countries (Fig. 14).

Kozen was also a gifted engineer. On September 1834 he headed the Rocket division which manufactured military rockets and improved their technology. Due to him Russian army had got the best modern military powder rockets. For this service Kozen was awarded by the order of White Eagle and in 1845 he became the general of the artillery.

Figure 14. Piotr Kozen.

The first in Russia optical telegraph line was built just according to the project and under the direction of Major General Piotr Kozen. It was opened in 1824 and connected St. Petersburg and Shliesselburg [13, p. 128]. This line was designed for transmission the messages about shipping in Ladoga Lake. It was dismantled in 1836 after 12 years of successful work.

Unfortunately, the technical details of Kozen telegraph are unknown. Probably it was based on Agustín Betancourt system, who served in Russia from 1808 (Fig. 15). Perhaps Betancourt consulted the project on early stages of development.

Figure 15. Agustín Betancourt.

III. Optical telegraph of Pierre-Jacques Chatau

During the reign of Emperor Alexander I the optical telegraphy was not attracted much attention (it is surprisingly indeed but even the experience of Agustín Betancourt seems remained unclaimed).

However, in the times of Emperor Nicholas I the energetic activity on introducing the new kind of communication began. The special Committee of Military Ministry was established for consideration of new optical telegraph projects. During the period of 1828-1833 this Committee examined many projects. Among them were the projects of Russian inventors – merchant from Irkutsk Feodor Schegorin (? – after 1832), outstanding architect and builder Major General Lev Carbonier (1770-1836) and some projects of foreign inventors mainly Frenchmen such as Alexander Ferrier, Pierre-Jacques Chatau, Ennemond Gonon and others [13, p. 128].

The most successful was the project of Pierre-Jacques Chatau presented in 1823. Chatau was invited to Russia and already in 1833 under his guidance the telegraph line connected Winter Palace with Kronstadt (the main base of Russian fleet on Baltic Sea) via Strel′na and Oranienbaum was built. The government was satisfied by the speed and reliability of message transmission and the decision was taken about the further development of telegraph network in Russia.

In 1835 two lines between Winter Palace in St. Petersburg and the palaces in Tsarskoye Selo and Gatchina were also built. For the transmission of Tsar′s dispatches the special "telegraph observation room" was constructed on the roof of Winter Palace (Fig. 16).

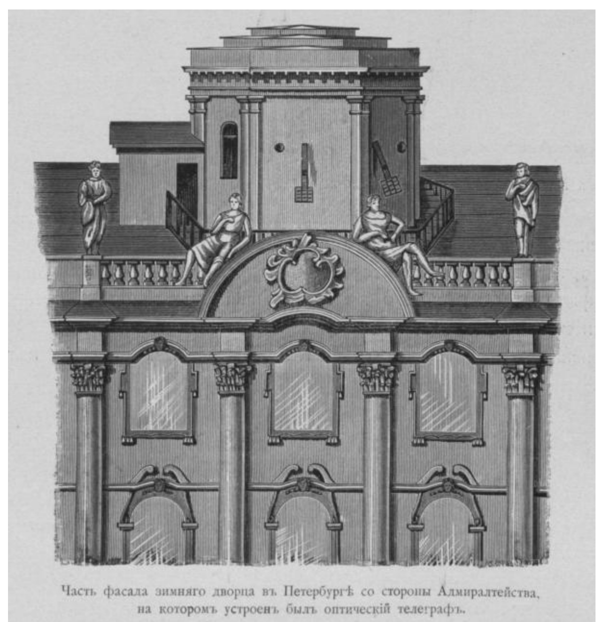

Figure 16. "Telegraph observation room".

Also in this year Emperor Nicholas I ordered to lay the telegraph line to the western outlying districts of Russia – to the Poland. The agreement was signed with Chatau according to which he "gave the secret" (the "secret" was in fact the system of coding) of his telegraph to the Russian government for the 120,000 rubles .

The construction of this line took three years and finally ended in 1838. It was tested all the next year and on 20 December 1839 the line began the round-the-clock operation. Emperor Nicholas I personally was presented at its opening (Fig. 17). The first message of 45 signs (Fig. 18) was transmitted from St. Petersburg to Warsaw for 22 minutes.

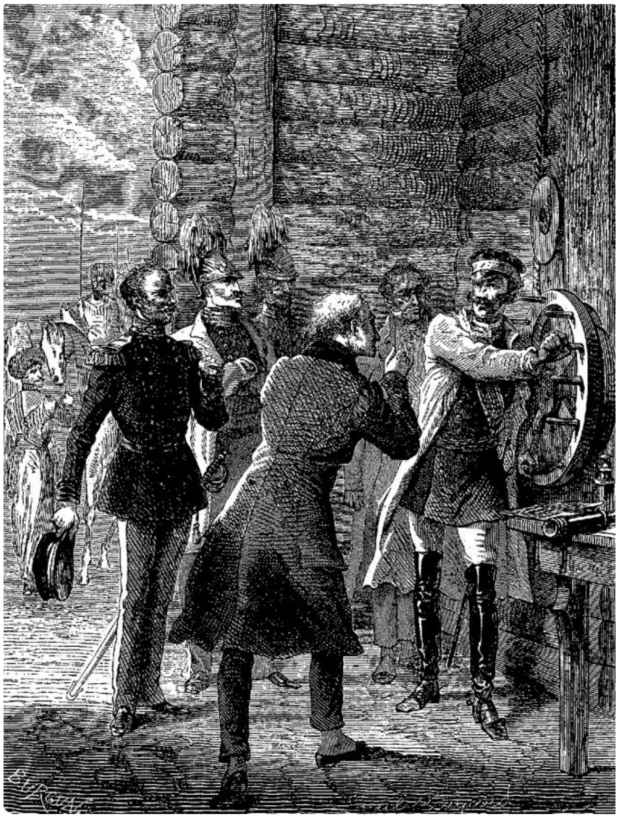

Figure 17. Emperor Nicholas I at the opening the telegraph line between St. Petersburg and Warsaw.

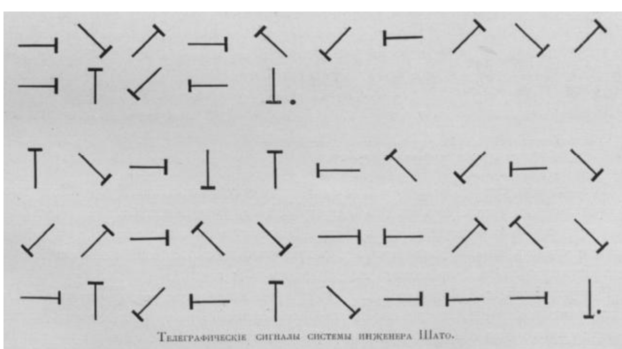

Figure 18. The first message transmitted from St. Petersburg to Warsaw.

The line of 1200 kilometers long was divided in 6 sectors which were directed by its own Direction. Directions were located in St. Petersburg, Pskov, Dinaburg (now Daugavpils, Latvia), Vil′no (now Vilnius, Lithuania), Grodno, and Warsaw. Twenty five towers were built at the each of the five first sectors and twenty four at the last sector (149 towers in total). Towers had the height from 15 till 17 meters (Fig. 19). Each Direction had in its disposal the staff of 115 signalmen and 66 servicemen. In total the personnel of telegraph line was consisted of 1908 men.

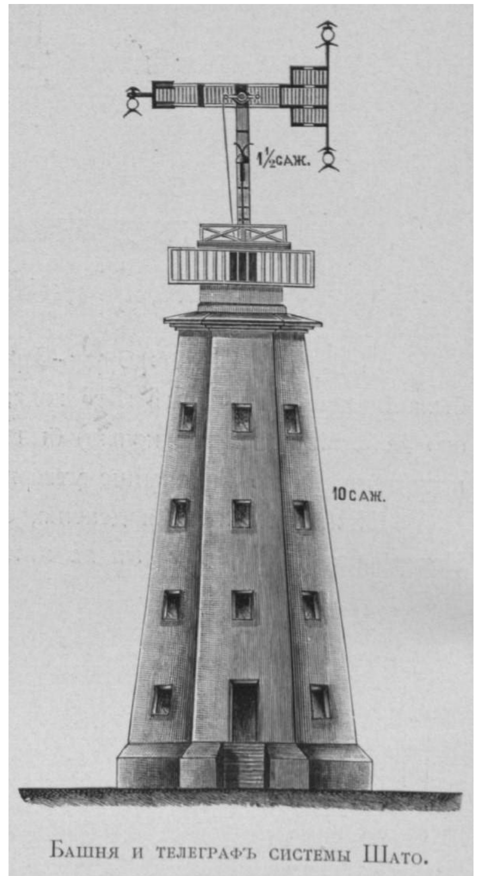

Figure 19. Chatau telegraph station.

The construction of Chatau telegraph was simpler than Chappe′s one. For the message transmission the T-form "semaphore rod" was used. The lanterns located on its three tips were lighted in darkness. 196 rod positions coded the separate signs, letters and words. Messages were transmitted in three kinds of code – military, civilian and service.

Semaphores were controlled by special operators inside of towers with the help of ropes and winches (Fig. 20 and Fig. 21 shows the station of Prussian telegraph, c1835). Four telegraphers were in turn on round-the-clock duty. Signalman wrote all the received and further transmitted messages in the special log (he pictured the positions of semaphore rod) and indicated the time and his name. Telegrapher during transmitting simply repeated rod positions on his tower duplicating the rod positions of transmitting tower which he observed by telescope. So he did not know the content of the message. Observations were made with the help of two telescopes which were fixed on two opposite walls and directed on previous and next following towers.

Figure 20. Prussian telegraph station.

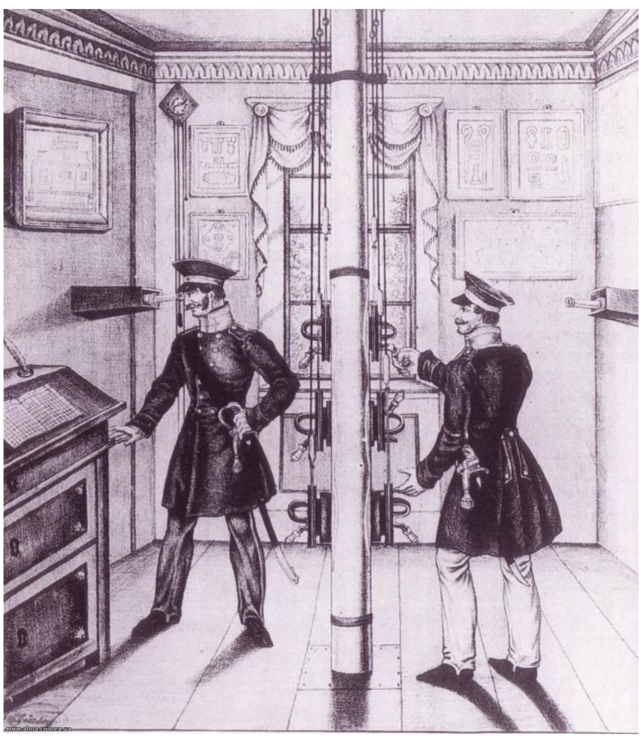

Figure 21. Signalmen at the Prussian telegraph station.

Usually signal transmission from St. Petersburg to Warsaw took 15 minutes and so the message of 100 signals transmission took 35 minutes. Thus, 5 signals were transmitted for one minute [14, p. 573].

Warsaw line became the last line built by Chatau in Russia. In 1840 he left the country having got the 6,000 rubles annual life pension. In 1842 he published the brochure [15] in Paris with the description of his telegraph (Fig. 22). Unfortunately, authors do not know about further life of Pierre-Jaques Chatau.

TÉLÉGRAPHE

DE JOUR ET DE NUIT

SUIVI D'UN

TÉLÉGRAPHE DE JOUR A DOUBLE TRANSMISSION;

PAR PIERRE-JACQUES CHATAU,

CHEVALIER DE L'ORDRE IMPÉRIAL DE SAINT-VLADIMIR.

Paris

CET OUVRAGE NE SE VEND PAS.

1842.

Figure 22. Title page of P.-J. Chatau brochure.

IV. Conclusion

The rapid development of Russian industry in the middle of XIX century demanded new more fast and open means of communications (for example, optical telegraph line between St. Petersburg and Warsaw and Kronstadt never was used for delivering private messages). The problems of state administration also set up the same demands. As a result at the beginning of 1850 optical telegraph gradually gave its positions to the electromagnetic one. Thus, in 1853 optical line in Kronstadt was replaced by underground and then submarine line across the Gulf of Finland. Warsaw line worked till 1854.

However, simplicity of optical telegraph and possibility for it fast deployment in the field attracted the attention of army for a long time.

For example, 7 September 1855 during the Siege of Sevastopol the French army successfully attacked the Malakoff redoubt. Old daguerreotype (Fig. 23) shows the optical telegraph mast erected on the tower of Malakoff Kurgan.

At the same time the modification of Edelcrantz shutter design was suggested by captain of Russian Navy Carl Otto Ramstedt (1813-1881) in the early 1850′s. It consisted of two columns of five rectangular shutters each, connected in five rows to a mast. Above this a large ball could be raised on the top of the mast, so increasing the code space to 2,048 different signals. During the Crimean War a line of about 80 stations was built along the southern coast of Finland connecting Helsinki to Turku in the West and Petersburg in the East. This line was dismantled in 1856, when the Crimean War ended [5].

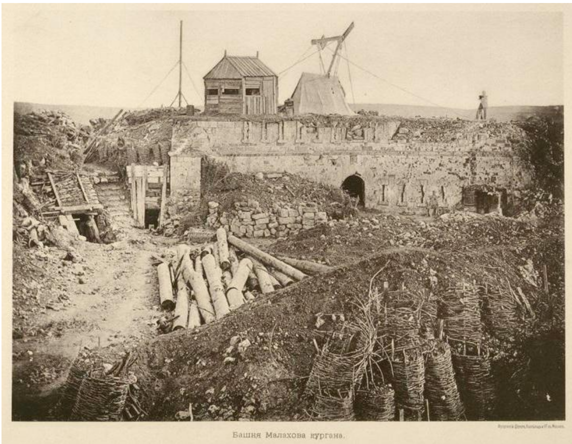

Figure 23. Optical telegraph at the top of Malakoff Kurgan.

Lieutenant General Stanislav Rekhnevsky (1833-1885), well known Russian military expert, professor of geodesy of Russian General Staff published in 1872 the book where he stated that though optical telegraph was inferior to electrical but it was the only means for providing the communication between rapidly moving squads. He gave the numerous examples of optical telegraphy applications in the armies of USA, England and Austria during the second half of XIX century [16, pp. 305-317].

Despite that the optical telegraphy was used in Russia for only 15 years it played a great role in the development of communications in our country. During this time an invaluable experience was received in exploitation of high-speed extended lines for transmission of encrypted and open information. Just exactly at the stations of optical telegraph the first operators of electrical telegraph were trained. First standards ([17] written by Chatau himself at al.) and legal regulations ([18, 19] at al.) of Russian telegraphy were established as well. Optical telegraph became the necessary step to the next stage of Russian telegraphy development – electromagnetic telegraph.

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