CONTINUING OF INDUSTRIAL REVOLUTION AT THE TERRITORY OF RECENT SLOVAKIA

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Abstract: *The contribution deals with industrial development in the phase of the Second Industrial Revolution at the territory of today's Slovakia. The Second Industrial Revolution, also known as the Technological Revolution, was a phase of rapid industrialization in the final third of the 19th century and the beginning of the 20th. In Hungary, however, due to the lagging behind industrialization compared to industrialized countries, the features of the second industrial revolution began to appear in the early 20th century. At the turn of the 19th and 20th centuries, Hungary made a purposeful industrial policy. The benefits of legislative and economic measures enhanced domestic and foreign capital investments, which allowed the application of technical inventions and technologies of the incoming second industrial revolution. The result was the development of a modern transport infrastructure and communication, the application of steam and electric driven engines, the development of mechanical engineering and production of electricity, the growth of new industries – mainly chemical. On the threshold of the First World War in 1913, paper industry and the textile industry had the highest share in value in Hungary. By that time, the focus of industrial development, with the exception of several sectors, particularly mining, paper and textile industries, has gradually shifted to territory of today's Hungary. Before the First World War, the main share of electricity production in Slovakia was produced in the local power stations of industrial plants, working mainly for their own needs. Paper is dedicated to students of technology and everyone who has interest for the history of mining engineering in context of Central Europe.*

Keywords: History of science and technology**,** History of Hungary/Slovakia, Industrial revolution, Industrialisation

1 INTRODUCTION

The second industrial revolution, also known as the technological revolution, was the phase of rapid changes in industrial processes in the last third of the 19th and early 20th centuries (Fig.1). It was a period of rapid economic development, especially in the UK, Germany, the United States, and France. Italy, Belgium and Japan. Austria-Hungary as one of the largest countries in Europe lags behind many indicators.

The first Industrial Revolution and most technological developments preceding it had little or no scientific base. It created a chemical industry with no chemistry science, an iron industry without metallurgy, power machinery without thermodynamics. Engineering were pragmatic application of knowledge in which was known how things work, but rarely was it understood why they worked. Therefore, beginning of industrial revolution is frequently marked as technical-science revolution. Applied science opened many opportunities. The science of metallurgy was advanced through the work of iron and steel under microscope, which paved the way for a scientific understanding of metal and the mass-production of steel. This paved the way developing the method for mass-producing steel. Other processes were developed for purifying various elements such as chromium, molybdenum, titanium, vanadium and nickel which could be used for making alloys with special properties, especially with steel. The science of thermodynamics was developed into its modern form. These scientific principles were applied to a variety of industrial concerns, including improving the efficiency of boilers and steam turbines. Development in physics laid foundations of the modern scientific understanding of electricity and magnetism.

Inventions occurred at a more rapid pace than ever before in history. Increasingly these inventions were the work of scientists and engineers working in the research laboratory rather than of self-taught craftsmen, as had often been the case in the eighteenth century.

Machines were perfected which could bore, plane, or grind metal with great precision. Machine tools such as the lathe, boring mill, and milling machine began turning out parts which were readily interchangeable with each other and could be assembled quickly without further shaping. Industrialists have understood of the tremendous possibilities for the mass production of goods that were inherent in the principle of the interchangeability of parts.

As the revolution continued there was a demand for more capital. While technology costs were coming down, the infrastructure demands of large factories or canals and railways were high, and most industrial businesses needed funds to start up and get started. As well as industry, banking also developed during the Industrial Revolution as the demands of entrepreneurs in industries like transportation or steel production led to a vast expansion of the financial system. [1]

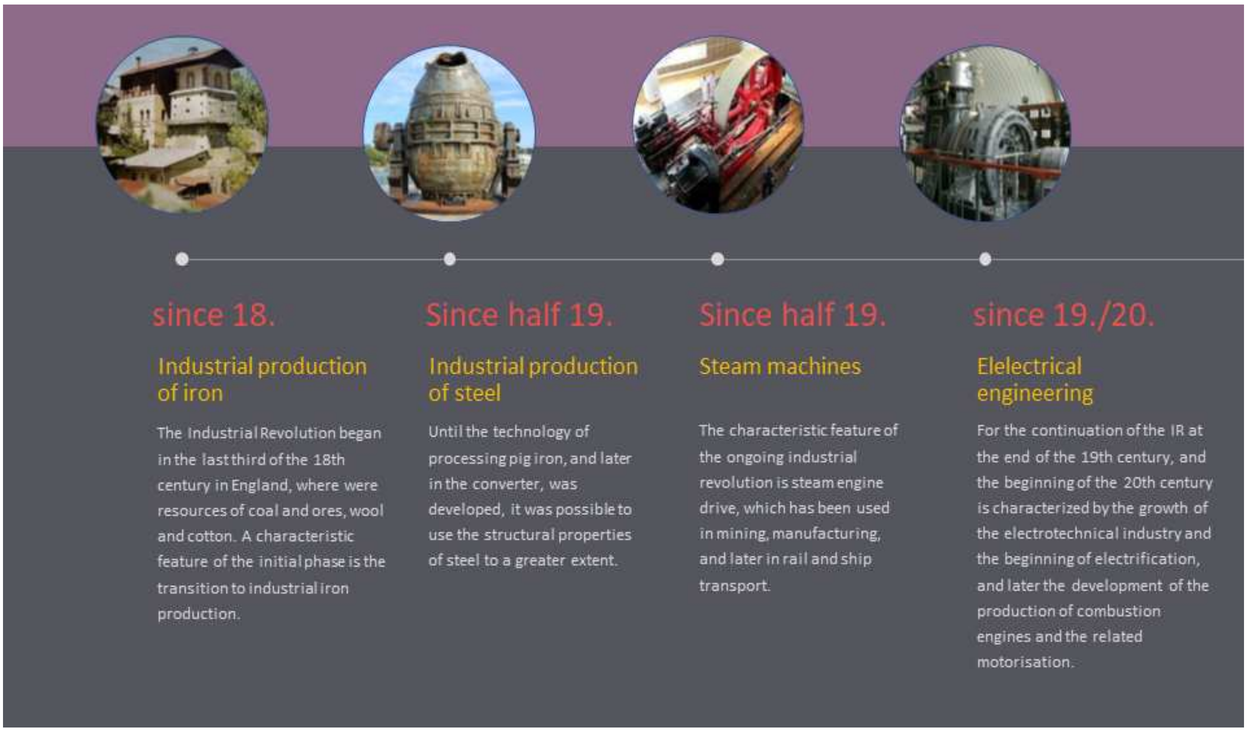

Fig. 1 C*ontinuing of industrial revolution*

2 NEW INDUSTRIAL TECHNOLOGIES

Applied science opened many opportunities in 19th century. The science of metallurgy was advanced through the work of iron and steel under microscope, which paved the way for a scientific understanding of metal and the mass-production of steel. This paved the way developing the method for mass-producing steel. Other processes were developed for purifying various elements such as chromium, molybdenum, titanium, vanadium and nickel which could be used for making alloys with special properties, especially with steel. The science of thermodynamics was developed into its modern form. These scientific principles were applied to a variety of industrial concerns, including improving the efficiency of boilers and steam turbines. Development in physics laid foundations of the modern scientific understanding of electricity and magnetism.

The Second Industrial Revolution, also known as the Technological Revolution, was a phase of rapid changes in industrial processes in the final third of the 19th century and the beginning of the 20th. The Second Industrial Revolution was a period of rapid economy development, primarily in Britain, Germany, the United States, France, Italy, Belgium and Japan too. Austria-Hungary as one from biggest countries in Europe in many indicators lagged behind.

A synergy effect between iron and steel, coal and energy or electrical energy led to continuing of industrialisation. Advancements in industrial technologies enabled the widespread adoption of pre-existing technologies and adoption of new that, such steel production, chemical technologies and electrical power production, helped fuel the Second Industrial Revolution and led to changes in economy and in social and political relations. The Second Industrial Revolution continued into the 20th century with early factory electrification petroleum processing and the production line, and ended at the start of World War I.

The second industrial revolution can also be characterized as a shift to wider use of new energy carriers. Into Industrial Revolution, the main energy carrier is wood and water. The transition to a concentrated energy carrier such as coal, electricity, or later oil products allowed industrialization. These fuels have enabled development metal processing and transport systems development.

Hot Blast (steam powered) was the single most important advance in fuel efficiency of the blast furnace and was one of the most important technologies developed during the Industrial Revolution. Along with using coal it has created preconditions for mass use of steel. Coke iron was initially only used for foundry work, making pots and other cast iron goods. The industrial development before second industrial revolution included innovations in the iron industry but had failed to yield technology for making low-cost steel production in large quantities. Then, sometimes after 1860, two processes made this possible for the first time. One known as Bessemer process (1856) and the other, the open-hearth process, known as the Siemens-Martin process (1868), because of the greater control which it gave over the quality of the steel, in time overshadowed the Bessemer method. With these two inventions, and a process devised in the 1870's for using less quality iron ore, the price fell by more than half within a brief period. The quantity produced increased rapidly (it is mentioned, that between 1860 and 1914 world steel production multiplied more than one hundred-fold). The production and processing of steel enabled the development of rail transport and the realization of steel constructions such as bridges, ships and the like.

The application of steam power to transportation was hardly a novelty but railroads became faster, safer, and more comfortable during the second Industrial Revolution. Progress in the propulsion of naval ships resulted in sharp decline in transportation costs. The bicycle was a novelty in the deepest sense of the word; it did not replace an existing technique with a similar, more efficient one. The people who adopted the bicycle in the 1890s had previously walked or used public transportation. The bicycle became a means of mass transportation with incalculable effects on urban residential patterns, especially after the invention of the pneumatic tire in 1888 J.B. Dunlop. Development of engines with internal combustion adopted a new fuel, petrol and oil fuel and number of important original contributions led to the development of the automobile and car transportation. The effect of the automobile and the bicycle on technology was great. They also combined with the late nineteenth century ideas of interchangeable parts and mass production made possible mass production of cars.

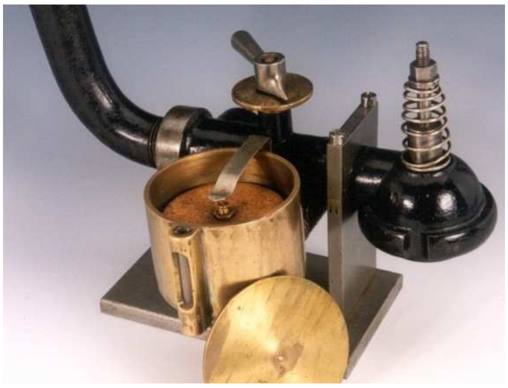

Fig. 2 Bánki-Csonka carburettor, an important invention that has allowed the development of automotive

The development of the airplane in many ways is paradigmatic of the new mode of technological progress that emerged with the second Industrial Revolution: formal and informal knowledge combining together to produce a discontinuous event followed by decades of microinventions which eventually produced a major industry.

The invention of production and transport of electricity is considered to be a milestone in revolutionizing of industries. At the turn of the 19th and 20th centuries, steam drives the greatest expansion and utilization, but at the same time, it has been gradually pushing for more efficient and more powerful electric drive. The technical development of the electric motor and the electric generator continued, adding new types of propulsion engines that could be used for direct drive of machines or for the drive of electric generators. An older type of Francis water turbine gradually added the modern design types of the Pelton and Kaplan water turbines. Since 1883, the technical development of the most powerful steam turbine engine has begun. Powerful propulsion engines in conjunction with the electric generator and the inventions of electric light bulbs, power grids, as well as other elements of electrical engineering, have enabled the onset of electrification since the early 1980s. Power grids supplied electricity to power and light to industries of various industries and for the needs of tertiary spheres. Major economic operators also built their own power plants.

Fig. 3 Károly Zipernowsky, Ottó Bláthy and Miksa Déri (ZBD), three engineers associated with the Ganz factory, in 1885 patented shell form of transformer.

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The first effective application of electricity was not in power transmission, but in communication. The construction of railroad networks also led to the development of infrastructure for the telegraph, which improved long distance communication. The telegraph, together with the railroads, was an early example of a technological system, a combination of separate inventions that had to be molded together. The subsequent invention of the telephone in 1876 by Graham Bell made real time communication possible and readily available. Industrial printing presses, the steam powered rotary printing presses, invented in half of 19th century allowed mass production of printed products - mainly newspaper or books. The typewriter was also invented. The light bulb enabled people to work at night.

In the 1890s, electric generators and remote power transmission, which are used in modern machinery and lighting, were crucial. Electricity translated to mass and inexpensive production of electro-chemicals such as magnesium and aluminium. Petroleum production and refining gave rise to products such as kerosene and gasoline. In industries, human labour was replaced by the use of machinery for efficiency. The invention of the internal combustion tractor replaced horses and mules and increased agricultural production. The new industrial processes translated into mass production, distribution and shipment, and fuelled the growth of international trade.

However, there is one innovation where the economic effect in terms of the further development of industrialization is unpredictable. The so-called American production system complex products were produced from mass-produced individual components. Modern production is unthinkable without removable parts. The production of interchangeable parts would not have been possible without the production of highly precise, specialized machine tools.

Interchangeable parts technology has proved to be excellent not only from a manufacturing point of view, but from a simple repair point of view, and therefore it was first introduced into the production of firearms by army and sequential into production of watches, mechanical locks of pumps, agricultural machines, typewriters, bicycle sewing machines and engines too. Another "invention" was the division of production into a simple ending, which was also able to be performed by unskilled workers. These innovations eventually led to the introduction of serial production.

Fig. 4 Ford T, the first mass produced car, in 1914 Ford sold almost a quarter of a million model T automobiles per year

The combination of the production of replaceable components and modern production organizations leads to the establishment of production lines and laid the foundation for modern mass production.

At the end of the 19th century, the foundations of modern organic chemistry were laid without which the chemical industry would not be possible. It was one of the most significant examples of how formal scientific knowledge influenced production technologies. Artificial dyes accelerated the textile industry, the invention of dynamite construction production under geologically demanding conditions, the production of artificial fertilizers influenced agriculture. Chemistry has also begun its way towards delivering new artificial materials: a rubber vulcanization process has been invented, which has enabled extensive industrial use of rubber, the first synthetic plastic, celluloid, which later became synonymous with the film industry, the breakthrough in synthetic materials was bakelite, in the 20s of the 20th century. Let us not forget the birth of a new chemistry department that has come up with substances for disinfection, anaesthesia or medicine like aspirin.

3 THE OVERALL CHARACTER OF INDUSTRIALIZATION BEFORE CZECHO-SLOVAKIA

In the period from the 1990s to 1914, the industrialization of the country and the building of modern infrastructure, especially railways, have accelerated in Hungary. The Hungarian government has made great efforts to promote industrialization, in particular through statutory measures. On the basis of the so- Industrial Laws adopted in 1907 provided industrial firms with tax and tax concessions, favourable rail fares for raw materials and finished products, and direct financial subsidies and other benefits. At the same time, the government provided sales to the entire industry with regular state orders, especially for the army, and protected the domestic measures of domestic production against foreign competition. During the inter-war period, this economic policy of Hungary was called "greenhouse" in Czechoslovakia, which meant that the Slovak industry was built under artificial protection in 1918 and not under natural market conditions. [2]

At the turn of the 19th and 20th centuries, Slovakia focused on the development of several light industries, typical of the early industrialization phase. This was mainly about the textile, paper, food and leather industries. At the same time, however, the most progressive sectors emerged relatively successfully, such as the chemical and electrotechnical industries. These industries have already been a characteristic part of the higher industrialization phase, running around the last since the last decade of 19th century into the First World War.

The total volume of production grew and technically improved the heavy industry, represented mainly in Slovakia by traditional mining and metallurgy. However, the importance of Slovak metallurgy for the whole Hungarian economy has gradually decreased since the late 19th century. It was paid especially for iron metallurgical iron ore spreading, but increasingly moved to the territory of today with Hungary. As a result of depleted stocks and competition on world markets, the importance of mining of ores containing precious and non-ferrous metals, with the exception of antimony and manganese, also declined. On the other hand, the territory of Slovakia was the world's largest magnesite producer before the First World War. Production of brown coal and oil has begun. Thus, crude and non-profitable mining continued to have a large share of industrial production in Slovakia. [3]

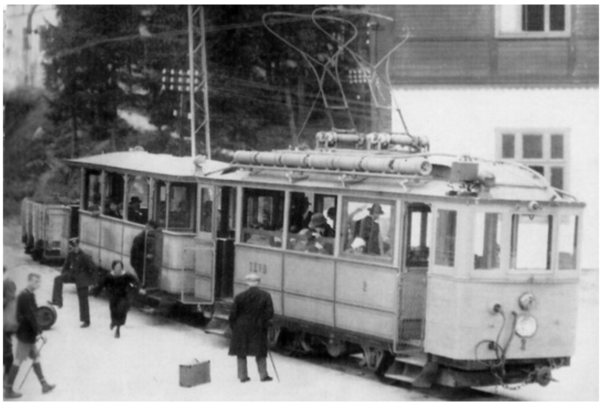

Fig. 5 The first passenger tram started operation from Poprad to Starý Smokovec on December 20, 1908. The tramways were produced in the Ganz Budapest.

The use of electricity was one of the main phenomena of the late 19th century. During the second industrial revolution at the turn of the 19th and 20th century, a independent industry - the electrical engineering industry - was also developed. The new industry supplied drives, wires and equipment for the production, transmission and use of electricity. [4, 5] Pioneers of the electronics industry in Europe have become well-known companies such as Siemens, AEG, Philips and others that have gradually expanded to Central and Eastern Europe from the West. In each country, however, significant domestic electrical companies also emerged. An exception was not Hungary as well as the territory of Slovakia. [6]

The Ganz Works or Ganz (Hungarian: Ganz vállalatok) was a group of companies operating between 1845 and 1949 in Budapest, Hungary. It was named after Abrahám Ganz von Embrach was a Swiss born Hungarian iron manufacturer whose company, Ganz, became one of the biggest industrial companies. Ganz also made ships, bridge steel structures and high voltage equipment. It is probably best known for the manufacture of tramcars but was also a pioneer in the application of three-phase alternating current to electric railways. Lanz purchased a license for a cylindrical bench that has engineered and used cast iron casts with its proprietary patented technology used to cast railway wheels. At that time, the production of mill equipment was one of the main production programs. Ganz technicians Donát Bánki and János Csonka were co-founders of internal combustion engine manufacturing in Hungary and their engines were mass produced by the Ganz & Partner Iron Foundry and Engineering Works. They had many problems with the ignition of petrol engines due to uneven mixing of gases: the device, generally used in that time to vaporise petrol and mix it with the air, could not produce the precise mixing proportions. The carburettor patented by Bánki and Csonka in 1893 and displayed at the Paris World Fair in 1900, immediately eliminated these problems. Theirs was the first carburettor in the world, nevertheless the credit is often given to the German engineer Wilhelm Maybach, whose patent was, however, submitted only half a year later. [7]

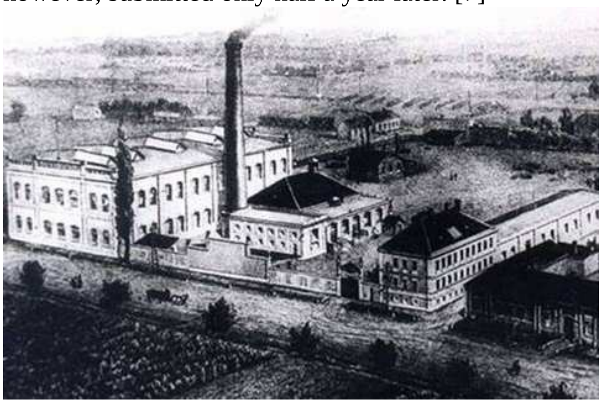

Fig. 6 In 1902, the Siemens Siemens-Schuckert plants were established, the first factory of Siemens to produce generators, electric machines, apparatuses and transformers on the territory of Slovakia. Its founding stimulated the ordering of electric lighting for the then 65,000 inhabitants of Bratislava.

At the turn of the 19th and 20th century, one of the centres of the Hungarian electrical industry became Bratislava. Already in 1895, the Austrian businessman with electric conductors Egon Bondy established a subsidiary of his Vienna business. From a small plant over the next twenty years, the Factory of Cables Company has grown, becoming the largest producer of electric wires in Hungary.

Fig. 7 Tramway today, popular under the name of Comet, is probably the most famous Tatras tram, because it survived to this day. Ganz delivered the tram in 1913. Siemens supplied the electrical equipment from Siemens & Schuckert. It was already built at 1650 V. The tram had three brakes. pressure, electric resistance and manual mechanical. Each axle was powered by one engine with a power of 40 kW, max. speed was 30 km / h.

In 1911, the Cable Factory built a Gumon plant in Bratislava, specialized in the production of insulating materials. Its significance increased in 1915 when he obtained the patent for one of the first plastics - bakelite. Bakelite became significant material using in many sectors.

The next step in the development of electrical engineering in Slovakia was the result of an expansion of international capital. In 1901 Schuckert started to build a plant in Bratislava. In the following year, German giant Siemens absorbed him. The company mainly produced alternators, dynamos, switchboards, later pumps, transformers, lifts and cranes. Bratislava subsidiary of Siemens supplied equipment for example to the municipal power plants as well as to the electric railway in High Tataras. In Bratislava, Trenčín and other cities, other smaller electrical installations arose before 1918. Until 1918, approximately 1,100 people worked in the Slovak electrical industry.

Fig. 8 The Ganz Eg6 electric locomotive traveled on the Bratislava - Vienna route from 1914 to 1945. The current state. Slovak Technical Museum.

The Dobšinská Ice Cave is one of the first electrically illuminated caves not only in Europe but also in the world. The first attempts at electric lighting date back to 1881, and electrical lighting was installed in 1887.

4 CONCLUSION

The second Industrial Revolution was, in many ways, the continuation of the first. In many industries there was direct continuity. Yet it differed from it in a number of crucial aspects:

1. Technology development had a direct impact on real wages and living standards, which varied considerably in 1914 from 1870.
2. The introduction of electricity has affected many trade unions, transport and lifestyles. They laid the foundation for the development of communication in the next stages of the Industrial Revolution.
3. Finally, changing the relationship between nature's knowledge and how it affected technological processes has irreversibly changed the way in which technical change occurs. This has paved the way for the industrialisation in territory of Slovakia.

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