

History of Machine Building Industry



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Abstract The chapter is structured in four parts. In the first part, the beginning of industrialization in Romania is presented. The industrialization of Romania begins in the first part of the eighteenth century, when the demand for mineral resources (coal and iron) of the western European countries increased considerably. These resources began to be exploited in the “Banatul Montan” area, where the first furnaces appeared. Later these were extended to other areas of Transylvania. If initially the production was predominantly focused on the metallurgical sector, starting from the second part of the nineteenth century it was expanded in the field of machine construction (household and agricultural tools, cast iron objects, locomotives, etc.). The second part presents the development of the machine industry in the period between the two world wars. The formation of Greater Romania, after the First World War, strongly boosted the development of Romanian industry, especially by supporting domestic capital. During this period, the first Romanian entrepreneurs appeared who strongly developed the metallurgical, railways, armaments, and aviation industries. The third part of the chapter analyzes the development of the machine industry after 1945 until 1989. After the Second World War, the political reality changes completely through the change of the political regime and the entry of Romania into the Soviet occupation zone. During this period, part of the Romanian industry is abolished (the aeronautical industry, armament industry) and the industry of agricultural machines, energy equipment, transport equipments, consumer goods, textile equipment, etc. is developed. From the 1960s until the beginning of the 1980s, a strong industrialization took place throughout Romania, trying to cover all the industrial needs of the country. After 1989, with the fall of the communist regime, the machine industry was affected by several major events: the transformation of state enterprises into commercial companies; the privatization of commercial companies; the decline of the export market to former communist countries, Arab countries and African countries; globalization,

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through the emergence and development of subsidiaries of large international companies; the opening of borders to foreign products; the rapid increase in interest rates. These events led to crucial changes in the Romanian industry, the context in which the new enterprises operated being completely changed compared to the one before 1989. The reindustrialization of Romania after 1989 occurred mainly through two mechanisms: the first, through the purchase, restructuring and re-engineering Romanian enterprises by the big players on the world market or by Romanian investors with an entrepreneurial spirit; the second, by setting up enterprises of foreign companies in locations with skilled labor or in geographical areas with a surplus of (cheap) labor that do not require a high qualification. At the end of the chapter, a panoply of research and design institutes in the field as well as higher technical education institutions in the field of machine construction technologies is presented.

The industrial revolution reached the Romanian territories with a delay of over half a century compared to Western countries (England, Germany, France, the USA). Entry (Imreh 1955) of the bibliography presents in great detail the process of the passage from manufacture to industry in Transylvania. The Imperial Patent of 1851 (an official document issued by Emperor Franz Joseph) led to a new administrative redistribution of Transylvania, cutting back on the privileges of guilds (abolished in 1872). The Chambers of Commerce of Cluj, Braşov and Timișoara were established in the same year, resulting in an impetus given to manufacture and opening the way to industrialisation in Transylvania. The first *steam engine* was used in the mining industry, in Zlatna, set up in 1838 (Imreh 1955); in 1846, another such machinery (imported from France) was also set up at the mill of Păcurari, Iași (*** 1963). Some years later, in 1853, the Assan mill was built in Bucharest, operated by a Siegel type steam engine, brought from Vienna (Assan 1904). However, the first signs of the industrial revolution did not show until the late nineteenth century, at the time of the reforms of Alexandru Ioan Cuza, of the formation of the independent state, and of the law of 1887 meant to encourage the national industry (entitled ‘*General measures to assist the national industry*’). It was at this time that the industry witnessed a significant growth as a result of the introduction of machines as the driving force in production. Towards the end of the nineteenth century, these machines, imported from England, Germany, Austria and France, started to be used in mining, oil industry, food industry, forestry, transportation, textile industry, etc. (for details, see Chap. 6, Formation of the industrial system). In the first stage of machine building in Romania, the machine production mainly covered agriculture, railway industry, naval industry, oil industry, and military equipment. In what follows, the main machine building factories on the territory of Romania will be presented in the course of their history.

1 The Beginning of Machine Building Industry Before the First World War

After the Passarowitz Peace Treaty of 1718, the Banat region was placed under Habsburg rule, as an estate of the Crown. The Transylvanian Court Chamber (the governing body which connected the Court of Vienna and the Transylvanian local authorities) approved, in 1725, the project of Governor Mercy to establish manufactures and produce locally the goods necessary for consumption. As a consequence of the Austrian state's interest in making the most of the potential of this region, important economic changes (mainly in mining and metallurgy), as well as social changes had taken place. *The first iron ore melting furnaces* on the territory of Romania were built by melting masters from Tyrol and Bohemia at *Ciclova* (1718), *Oravița* (1718) and *Bocșa* (1719) (***) (1996). Thus, the mountainous Banat region became the oldest industrialised area on the territory of Romania. In 1756, the furnace of Bocșa was moved to *Reșița*, where the first furnace was built in 1771 (***) (1996) (Fig. 1). This area is also one of the first regions of Europe in this respect, preceding the establishment of famous factories such as Krupp (1811), MAN (1834), Škoda (1851), etc. Due to the rich iron ores and coal resources of the area, the Austrian Empire (which was ruling over Transylvania and Banat until 1918) invested massively and introduced state-of-the-art machinery and technology. *The first steam engine-driven rolling mill* was built in 1845 and the *first steam engine operated presser in Romania* was set up in 1846 (Imreh 1955). This presser was set up at Reșița shortly after it was invented by the Englishman Nasmyth (in 1830) and built by the French Bourdon (in 1839). Such types of pressers were also built at Plosca (Dolj County) in 1851, Vlăhița (Harghita County) in 1856 and Filia (Covasna County). Consequently, while the industrial production originally focused mainly on metallurgy, later, in the second half of the nineteenth century, it was also extended to machine building (household and agricultural tools, nails, cast iron objects, etc.). Such a factory existed in Rușchița, in the area of Poiana Ruscă mountains, in 1834. In 1854, the works at Reșița were moved from the ownership of the Austrian Treasury to that of the Imperial Royal Privileged Austrian State Railway Company (StEG, Staats-Eisenbahn-Gesellschaft). This had resulted in a major change of the production profile, focusing on railway services: railway equipment, rails, crossings, etc., and later wagon and locomotive maintenance. The experience gained in the process led to the manufacturing in 1872 of the *first steam engine on the territory of present-day Romania*. It was a narrow-gauge locomotive named Resicza 2, used for transportation within the premises of the factory. The engine was designed by the famed English steam engine designer John Haswell, who had been working at the StEG Locomotive Works since 1839. Before 1918, seven more such locomotives were also produced at Reșița (***) (1996).

After the First World War, in 1920, the works from Reșița were transformed, becoming the Steel Works and Domains of Reșița (U.D.R.), and the largest inter-war company in metallurgy and iron and steel industry (employing almost 23,000 workers in 1948) (Chicoș 1925; Popescu 1929). During this period, the works were equipped with modern machinery, such as a high power press. Until 1940, the U.D.R.



Fig. 1 Reșița before the First World War (***) 1996)

had a successful administrator: Max Ausschnitt. Ausschnitt and Malaxa were representative figures of the Romanian industrialists between the two World Wars. The production profile of the factory extended to the military as well (making anti-tank and anti-aircraft guns, shell throwers, etc.), metal works, oilfield equipment, and electric equipment (electric motors, transformers, etc.). In 1948, the Steel Works and Domains of Reșița were nationalized, and the establishment has repeatedly changed its name until taking its current denomination, the Reșița Machine Building Factory. In 1969, the *Reșița Plants Group* was established, which also comprised: The Bocșa Metalworks, the Caransebeș Machine Building Works, the Timișoara Mechanical Works and the Reșița Research and Design Institute for Hydroelectric Equipment. The factory's field of production extended and became more and more complex, covering also the building of hydroelectric equipment (the first Francis turbine for a 100 kW hydro-aggregate was built in 1946, as an *industrial premiere* in Romania). In addition to various kinds of hydraulic turbines (Pelton, Francis, Kaplan), beginning with 1977, it also produced thermo-energetic equipment (steam turbines, turbo generators and other associated equipment), naval engines, and large size reducers (at the new reducer factory at Reșița-Renk, established in 1973). The plant was reorganized in 1991 to become a joint-stock company, then in 2003 it was privatised and bought by the Swiss INET company. In order to showcase the importance of this plant for Romanian economy, some significant numbers for production volume by various fields will be presented: 1,461 locomotives, over 6,000 industrial air compressors, electric motors with a cumulated power of over 1.5 million kW, thermo-energetic equipment with over 1 million kW of installed power, Diesel motors for locomotives and ships with a cumulated power of over 10.8 HP, hydro-aggregates (hydraulic turbines/electrical generators) with over 6.2 kW power (Wollmann 2010–2018).

The Ferdinand Plants (named after the first owner, Ferdinand Hoffman) were founded by German colonists in 1796 (** 1996). In the second half of the nineteenth century (1861) the plants were extended, and a jobbing mill, a five-stand rolling mill for making rails, and a light sheet rolling mill were built (Fig. 2). In 1924, the plants became part of the United Metallurgical Works *TITAN-NĂDRAG-CĂLAN SAR* founded by Max Ausschnitt. After the nationalisation, the town changed its name to Oțelul Roșu (1964) and the Ferdinand Plants to *Oțelul Roșu Steelworks* accordingly. The works was privatised in 1990, sold to foreign investors in 2000, and eventually it was closed in 2012. Another important steelworks centre in the mountainous part of Banat was Anina. The ironworks were built here in 1861, and in 1872 a *Screw factory* was built, producing assembly elements (screws, rivets, etc.). The factory worked until after the First World War. In 1872, the Nădrag Industrial Society for Iron was established, where several furnaces, steelworks, a foundry, a rolling mill, a factory for rolls, a machine factory and one for agricultural machinery and tools were built between 1880 and 1918. In 1924, the society was integrated into the *TITAN-NĂDRAG-CĂLAN SAR*. A *Factory of agricultural machinery and tools* was functioning in Bocșa, in 1898. Later it was renamed the *Bocșa Metal Building Company (CMB)* and focused on metalworks for industrial, public and thermo-energetic use (metal bridges, tower cranes, elements for nuclear power plants, etc.).

Another traditional centre dating back to the eighteenth century in the field of metallurgy and machine building in Transylvania was Cugir. In 1799, an *iron factory* was established here which processed the iron ore mined at Govăjdia, near Hunedoara (** 1974). The factory was extended and modernised repeatedly, in 1850, 1873



Fig. 2 The Ferdinand plants in the nineteenth century (Wollmann 2010–2018)

and 1898 (Fig. 3). In 1873, the factory had 106 employees, in 1900 it had 500 employees, and in 1913, after it was connected by railway to the Deva-Sebeş railroad, it reached almost 1,000 employees (***) (1974). In 1920, the factory in Cugir was nationalised. A significant time in the history of the factory was the year 1925, when, following the Paris Convention, the factory of Cugir began producing ammunition, purchasing equipment from Vickers in England and Skoda from Czechoslovakia. The first Romanian automatic pistol, designed by Captain Marin Oriță, was also produced in this period, in 1941. In 1948, the factory was renamed the *Cugir Mechanical Works*. The production covered the manufacture of machine tools, becoming one of the largest machine tool designers and producers in Romania in the 1950–1970 period. This is where *the first machine tools in the country were made in 1946: machine tools for grinding, milling (1948), drilling and tool sharpening machines, and the first gear milling machine (1963)*. After this pioneering period of machine tool building, the production was transferred, beginning with the 1970s, to other factories in the country: the milling machines to the Brotherhood (Înfrățirea) company in Oradea, grinding machines to the Tools and aggregates factory of Bucharest and then to the Grinding machine factory in Cluj Napoca, the tool sharpening machines to the Plopeni Mechanical Works, etc. Based on this, one might say that the Cugir Mechanical Works was the main provider of machine tools for the Romanian industry in the 1948–1965 period and this factory was the *cradle of machine tool production in Romania*. Starting with 1946, household machines were also built at Cugir. This is where the *first industrial sewing machine from Romania called MCI-1 was built in 1946*, and the production of household sewing machines began in 1948. The first type was *Casnica*, followed by many other types, with millions of such machines being built before the factory was closed. Another household machine which was produced beginning with 1961 was the washing machine, the first type in production being the *Albalux 1*. This was the *first washing machine manufactured in Romania*.

The first machine building factory from Romania (agricultural tools) was established by the Solymos brothers in Arad in 1825 (Wollmann 2010–2018). In 1891, the Austrian Johann Weitzer founded the *Johann Weitzer Wagon and Engine Factory* (Fig. 4). The factory was founded in order to cover the needs for rolling stock (wagons, carriages, locomotives, electrical tramways, but also military equipment, field kitchens, agricultural machines) (Fig. 5) for the eastern part of the Austro-Hungarian Empire. In 1909, the *MARTA Automobile Factory* was founded (Magyar Automobil Részvény Társaság Arad, the Arad Hungarian Automobile Joint Stock Company), a branch of the American Westinghouse company. The machines produced here were engines for locomotives, buses, lorries, etc. In 1910, it also made *the first car produced on the territory of Romania*, called MARTA. In 1912, the factory was taken over by the Austrian company Austro Daimler, continuing to make cars (called Daimler) as well as lorries and buses (Wollmann 2010–2018). After the union of Transylvania with Romania, in 1921, the *Johann Weitzer Wagon and Engine Factory* and the *Marta Automobile Factory* merged to establish the *ASTRA* society. This was the first Romanian factory to *manufacture railway vehicles, as well as automobiles, lorries, tractors, agricultural machines, airplanes and other aircraft equipment*. The portfolio of the factory diversified and the number of employees increased, becoming eventually one

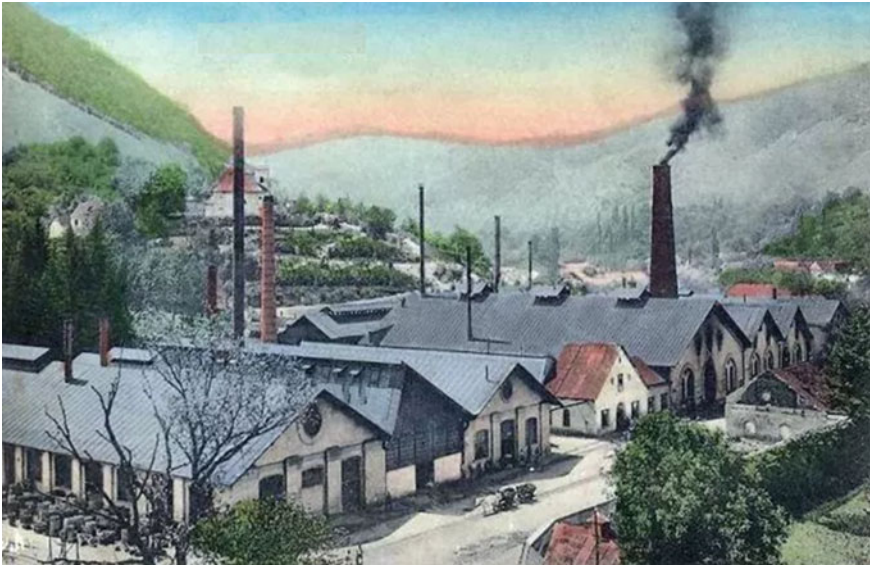


Fig. 3 Image of the Cugir Plant in 1912 (***) [1974](#))

of the largest factories of Romania (with 2,120 workers employed in 1926) (Fig. 6). Due to the experience in manufacturing the Daimler airplane engines, an airplane factory was founded in 1923. This was the *second industrial unit in Romania where airplanes were built*. The first airplane engine produced in Romania, called *Marta-Benz*, was made at the ASTRA Airplane Factory. This engine was used for the Astra-Şeşefski airplane, designed by engineer Şeşefski in 1923. Three airplane models were produced here: Astra-Şeşefski, Proto-2 and Astra-Proto. The airplane factory was moved to Braşov in 1925, establishing the *Romanian Aeronautics Industry— IAR Braşov*. At ASTRA Arad, precision lathes and power presses were being built already in 1924 (***) [1924](#)). The factory was extended to Braşov, Bucharest and Satu Mare. After the Second World War, the company was nationalised, keeping its main profile in the interwar-period: the building of wagons. When the subway in Bucharest started to be built, it also produced subway cars for the METROREX company, which oversees the Bucharest subway. In 1990, the factory transformed into a joint stock company under the name of S.C. ASTRA Vagoane Arad S.A, keeping its production profile.

The first mechanical/metal works workshop was established by Joseph Franz Teutsch in Braşov in 1833 (*The brass and bells foundry*) (Wollmann [2010–2018](#)). Initially, it produced bells for churches, candlesticks, scissors, irons and other household goods. After the dissolution of guilds, the workshop was changed into Iulius Teutsch Company in 1868, extending its profile starting from 1882 to the production of parts for different kinds of factories (sugar, textile, distilleries, sawmills, water mills, steam mills, etc. The factory profile did not change significantly after the First World War. In 1927, the factory changed its name to Teutsch Foundry and

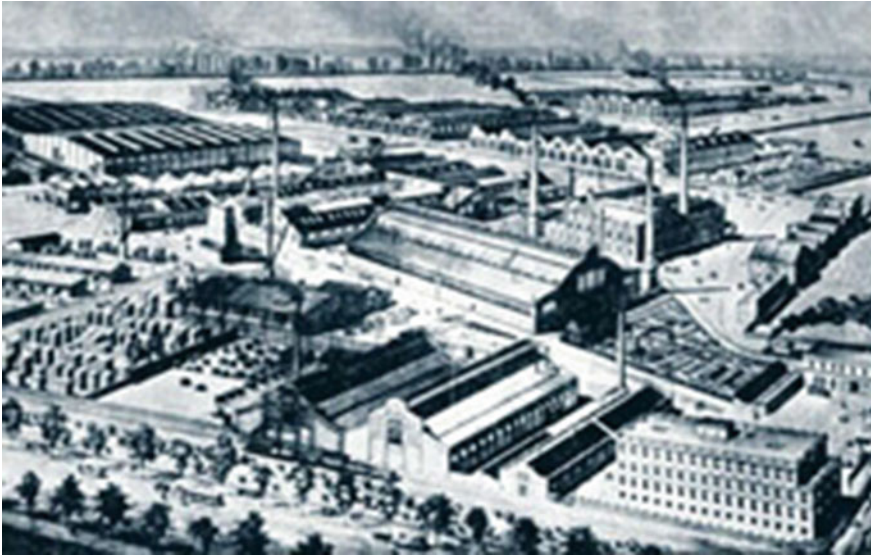


Fig. 4 The Johann Weitzer Wagon and Engine Factory at the end of the nineteenth century (Wollmann 2010–2018)

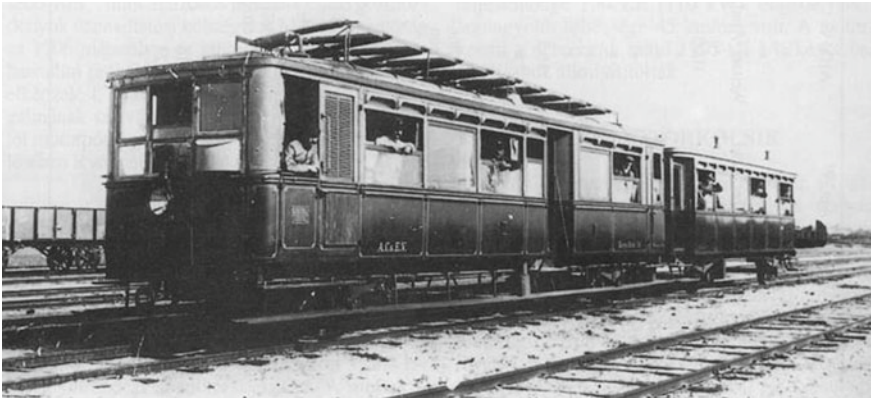


Fig. 5 One of the first railcars built at the *Wagon and Engine Factory* (courtesy of Dr. V. Wollmann)

Tool Factory, a name it kept until 1948, when it was nationalised. This is where *the first high-power presses of 30–60 ton-force in Romania* were built beginning with 1936, and *the first lathe frame (a national premiere)*. Because of these successful enterprises, beginning with the same year, the factory started reorganizing its profile to produce machine tools (lathes, drilling machines, presses), becoming the *first factory in Romania which manufactured such equipment*. After the 1948 nationalisation, the factory merged with two other factories of Braşov, forming the Tools

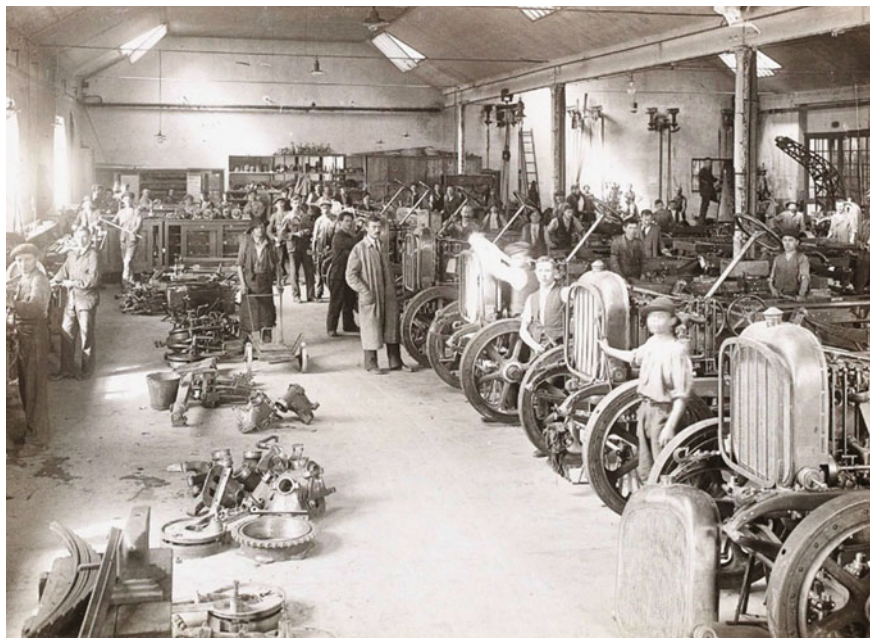


Fig. 6 Image of the assemblage department at *ASTRA* Arad (1921) (courtesy of Dr. V. Wollmann)

Factory (*Întreprinderea de Unelte și Scule, IUS*). In 1880, the brothers *Karl and Samuel Schiel* founded an *iron casting and processing workshop* in the *Schei Gate* area (Wollmann 2010–2018). In 1919, the factory turned into a joint stock company, taking the name of *Schiel Brothers s.a.p.a.* The factory extended its activities to locomotive and wagon repairs, equipment and parts for mining industry, building machines, mechanical transmissions and lathes. In order to reduce the costs of equipment acquisition, the factory *decided to produce its own machine tools* needed in production, specialising in this field. Figure 7 presents the image of a complex milling machine manufactured in 1942. In 1925, they started producing bodies for Fiat buses and later for Citroen buses. In 1924–1926 the Schiel Factory *designed and built the first airplane made in Brașov, Ra-Bo*. After the nationalisation of 1948, the factory was renamed *The Lathe (Strungul)*.

The beginnings of machine building in Cluj are connected to a legendary figure of the town, *Rajka Péter* (Imreh 1955). He was the son of a gunsmith from *Târgu Mureș* and a student of *Farkas Bolyai*, who graduated from the Technical University of Vienna. In 1840, he founded at Cluj a *workshop for agricultural tools* making straw choppers (with an original design, highly efficient), sowers, threshers, etc. He designed and manufactured a reversible plough with a new concept, which was considered *one of the best ploughs in the world* in that time (the 1870s). *Rajka* opened in his business a school as well, which trained craftsmen from all over Transylvania for several decades. After *Rajka's* death, the factory repeatedly changed

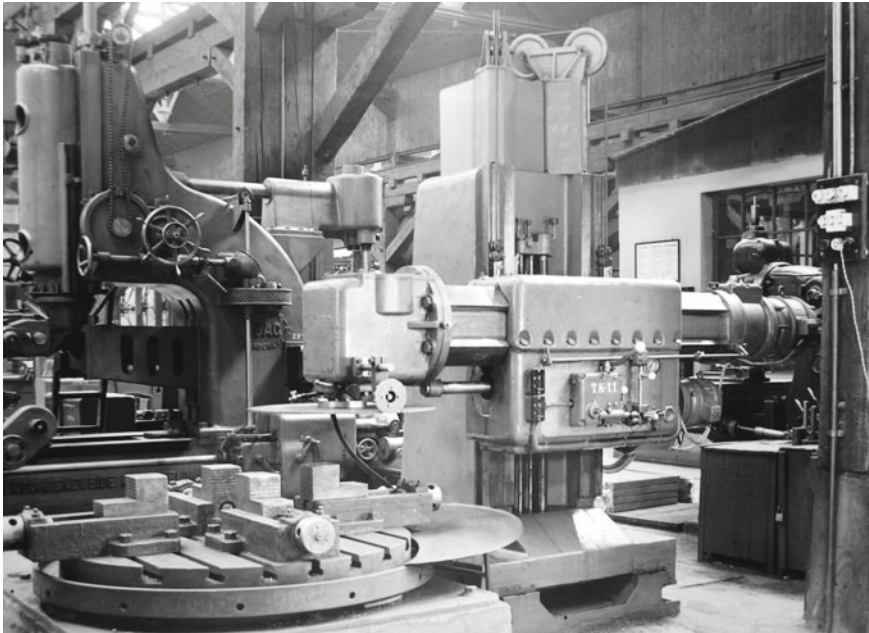


Fig. 7 Milling machine manufactured at Schiel Factory in 1942 (courtesy of Dr. V. Wollmann)

its name to *Wagner and Dietrich*, then in 1904 to *Junász Metalworks and Machine Building Factory*, specialising in hydraulic machines, heaters, mine lifts, etc. (Imreh 1955). In 1919, the factory was taken over by a Romanian society and changed its profile to producing charcoal irons, pressure tubes, etc. Beginning with 1933, the factory started producing the first machines for textile industry: mechanical looms, warping machines, recoilers, etc. (Giddo 2014; Pascu 1974). After the 1948 nationalisation, the factory changed its name to *Union (Unirea)* and produced machines and equipment for the textile industry (mainly looms). In 1870, the *Railways Workshops* were founded in Cluj with over 150 employees. The workshops underwent continuous development, so that in 1938 there were already 1700 employees, making it the largest machine building business in Cluj. After the 1948 nationalisation the workshop changed its name into *16 February* and currently it is named *Remarul 16 February*.

As there was a shipping route on the Danube with exit to the Black Sea which brought on the need to repair (and later build) commercial and military ships, dockyards were also established. The Treaty of Adrianople from 1829 ended the Turkish monopoly over the economy of the Romanian Principalities and opened the way to international navigation on the Danube and the Black Sea. As a direct consequence, it led to a major development of dockyards for repairing and building ships. The first ones were established on the Danube (Brăila, Turnu Severin, Galați, and later

Oltenița, Tulcea, Giurgiu) and then on the Black Sea shores (Constanța and later Mangalia).

The *dockyard of Brăila* was established in 1840 under the name *Romania Dockyard*. It was an important site for building ships for river and sea (cargo ships, barges, lifeboats, pilot ships, tugboats, etc.). Beginning with the end of the nineteenth century, by connecting the port of Constanța to the Romanian railway by the Saligny bridge (inaugurated in 1895), the ports and dockyards of Brăila and Galați gradually lost their importance. After the nationalisation, the shipyards from Brăila merged into one single site, the Brăila Dockyards. In the early twentieth century (in 1907) the first metalworking company of Brăila was founded with the name of *Triumph Metalworks (Întreprinderile metalurgice Izbânda)*. Its main profile was to produce iron laminates, and after the nationalisation it was incorporated into the Rolling Mill (Laminorul) company.

In *Iași*, the Italian I. Saketi founded in 1843, on the initiative of Ion Ionescu de la Brad, *the first factory of agricultural machines of Moldavia and Wallachia*, called the *Factory of Instruments (Fabrica de Instrumenturi)*. At the beginning, he employed German and French workers (Ghitoiu 1924). The factory produces tools for agriculture and threshers for cereals.

The Austrian shipping company D.D.S.G established in 1852 the *Turnu Severin Dockyard*. In 1893, the dockyard was transferred to state ownership and changed its name to *SEVERNNAV Dockyard*. In 1977, a factory of forged parts was built there, which merged with the dockyard and formed the *Drobeta Turnu Severin Naval Construction and Hot Working Company*. In 1882, a *Wagon and Locomotive Repairs Workshop* was founded at Turnu Severin. After it was nationalised, for a while (1960–1968) it merged with the dockyard of the town, forming the *Turnu Severin Mechanical Works*.

In *Oradea*, the first workshops for the production of agricultural tools were founded in 1844 and 1847, by *Gitye and Perge and Roszlay*, respectively (Hochhauser 2010). In 1860, *Daday* established a locksmith's and clock making workshop (Hochhauser 2010). In 1902, *Tátrai and Klier* as associates established a small company made up of a locksmith's workshop and a foundry, making metalworks and tinware (Hochhauser 2010). This workshop was the forerunner of *metal and mechanical works in Oradea*. After 1908, the company began to extend, reaching 120 employees and taking on the name *The First Foundry and Machine Factory of Oradea*. After the Great Union of 1918, the company was reorganized and in 1926 it took the name *Phoebus Iron Foundry and Machine Factory*. It began producing internal combustion engines for threshers, pumps, generators, etc., and later, from 1930, also equipment for oil industry (Hochhauser 2010). In 1936, the company was taken over by the French-Romanian Society (Societatea Franco Română, and in 1940, when Northern Transylvania was attached back to Hungary, the factory was evacuated and moved to Brăila, where it became the *Progress Plant (Uzina Progresul)*. In 1947, some smaller workshops in Oradea merged, re-establishing the *Phoebus* company (Hochhauser 2010). In 1948, following the nationalisation, the Phoebus

and some other smaller workshops were merged into a new company, the *Brotherhood (Înfrățirea) Oradea*, profiling on machine tool production (milling machines, drilling machines, processing centres).

The *CFR Timișoara Railway Rolling Stock Repairing Workshop* established in 1858, was the *oldest mechanical workshop in Timișoara* (Munteanu and Munteanu 2002). In 1960 it merged with the *Banat Metalworks* to become the *Timișoara Mechanical Works*. At the beginning, this company produced fire trucks, isotherms, rolling stock, naval winches, equipment for food industry, forestry tractors, etc. After 1970, the factory changed its profile to the production of transporting and lifting equipment (overhead cranes, forklifts, cranes). Later, after 1980, it started the production of mining equipment (rotor excavators, mechanized felling supports, and equipment of coal mines). In 1991 it became the joint stock company UMT SA and in 2000 it was bought by the PROMT SA company from Timișoara, making parts and subsystems for the well-known Caterpillar company. The first *metalworks company in Timișoara* was the *Bozsák*, established in 1869 (Munteanu and Munteanu 2002). It produced metal furnishing and metal nets. After the 1948 nationalisation, it changed its name to *Tehnometal*, and produced machines for agricultural products (selectors, sorting machines, threshers, seed driers, etc.). In 1980, it started producing low power tractors. In 1985 it changed its name to *Car Factory Timișoara (Autoturisme Timișoara)* and produced the low capacity car Dacia 500 Lăstun. It merged in 2006 with the Electrotimiș SA company, and took over the latter's production portfolio. In 1900, the *Iron Factory* was founded at Timișoara, which, after the 1948 nationalisation, merged with the *Iron Industry* company to form the *ELECTRO-MOTOR*, a company producing electric motors. This was the oldest electric motor factory in Romania. The *Friedrich Factory*, producing subsystems for locomotives and agricultural machines, was founded in 1900. The industrialist Schmitzer founded in Timișoara in 1908 the *Chain Factory*, which merged in 1944 with the *Britania Factory* (a producer of electric motors), founded by Zoltán Erőss, and the *Friedrich Machine Factory*, under the name of *Iron Industry* (Munteanu and Munteanu 2002). This factory produced mid-power electric motors, small compressors, machines for food industry, grain mills, oil presses, etc.). It was nationalised in 1948 and merged with the Iron Factory to form the *ELECTROMOTOR* company.

In Sibiu, a weapon making and repairing workshop existed ever since the mid-fifteenth century as part of the *Castle Arsenal*. For a period after 1529, the arsenal master was Conrad Haas, the crafter of the first multistage rockets. In the period between 1848 and 1918, the workshop became the *Army's Repair Workshop*. A major change in its profile came about in 1948, when it started to produce industrial equipment as well in addition to military equipment, and started to make repairs for tractors and railroad wagons. In 1964, the company changed its name to *Sibiu Automechanical Works (Uzina Automecanica Sibiu)*, focusing on the production of car parts, and in 1969 it merged with the Elastic Works (Uzina Elastic), forming the *Sibiu Car Parts Company (Întreprinderea de Piese Auto Sibiu, IPAS)*. The first machine building company in Sibiu was the *Fabritius Iron Works (Fabrica de construcții de fier Fabritius)*, established in 1855 (<http://patrimoniul.sibiu.ro/istorie/industrie/38>). In 1868, Andreas Rieger founded the *Andreas Rieger Machine*

Factory (Fabrica de mașini Andreas Rieger) (<http://patrimoniul.sibiu.ro/istorie/industrie/38>). The *Andreas Rieger Machine Factory* started out as a forged iron workshop, making horseshoes and repairing agricultural tools and machines. It specialised in producing ploughs, including the widely known Rieger system plough. This was the *first reversible plough produced in Romania, with cast iron stilts*. It worked as the *First Transylvanian factory of agricultural machines and iron foundry* until 1921, when the machine factory *Fabricile de mașini Andreas Rieger S.A.* joint stock company was founded. The new factory extended its line of production to hammer mills, cranes, pumps, threshers, mechanical saws, and from 1938 it also started producing spark ignition engines and Diesel engines, used with threshing machines. Also in 1938, the production (under licence) of textile machines also started (for instance, the Wolf weaving machine). In 1948, the factory was nationalised and, merging with the Virola company (founded by Friedrich Fabritius in 1855), they founded the *Independence Works (Uzinele Independența)*. The new company made equipment for metalworks, considered the ‘chief mechanic’ of Romanian industry.

In 1886, József Datky founded in Sibiu a craftsman’s workshop with the name *József Datky and Sons Bodyworks (Atelier de Caroserii Datky Iosif & Fiii)* (<http://patrimoniul.sibiu.ro/istorie/industrie/38>). In the beginning, it produced lamellar springs for coaches, forged parts, household tools, etc. From 1920 it changed its name to A. Datky Elastic (Elastic A. Datky), and extended production to parts for cars and wagons. The factory specialised in producing spiral springs, as the first factory in Romania to make such products beginning with 1932. Figure 8 presents a body produced at this workshop. In 1948, the factory is nationalised and renamed the *State Elastic Company (Întreprinderea Elastica de Stat)*, producing files, springs and forged parts until 1960. In 1969, it merged with the Sibiu Automechanical Works (Uzina Automecanica Sibiu). The new factory was called, until 1991, the Sibiu Car Parts Company (*Întreprinderea de Piese Auto Sibiu, IPAS*) and became one of the main producers of car parts for the Romanian car industry, making shock absorbers, brakes, cardan transmissions, steering gears, springs, etc. In 1991 the factory was transformed into a joint stock company and was renamed SC COMPA SA, and in 1999 it was privatised, becoming one of the successful private-owned companies of Romania. In 1902, the *Benker and Jickeli Machine Factory of Iron Foundry (Maschinenfabrik und Eisengieserei Benker und Jickeli)* was founded in Sibiu, which first specialised in automobile repairs, and after the First World War, on building machines for the textile leather processing industry (<http://patrimoniul.sibiu.ro/istorie/industrie/38>). Another important stage for the industry of Sibiu was the foundation of the *first balances and scales factory*. It was founded in 1905 by Johann Hess and produced medium and large weighbridges mostly for railroads and food industry factories. Later, after the First World War, they also produced small household scales or shop scales, and semi-automatic balances (<http://patrimoniul.sibiu.ro/istorie/industrie/38>). In 1930, the factory changed its name to *Hess Factory*. After the 1948 nationalisation, it maintained its original profile but extended it to the production of measuring devices as well, and changed its name to *Balance Company (Întreprinderea Balanta)*. In 1975, the factory also started to produce hydraulic and



Fig. 8 Car body produced at the A. Datky Elastic Factory (<http://patrimoniul.sibiu.ro/istorie/industrie/38>)

pneumatic equipment under Bosch licence, as the main producer of such equipment in the country and one of the few in Eastern Europe.

In order to better supply the Army with modern equipment, Prince Alexandru Ioan Cuza founded in 1861 the *Direction of the Establishments of Artillery Materials*. Within this institution, the army's *Pyrotechnics* and *Building Arsenal* were founded in 1862. These were *the first metalworks in Bucharest* (Manole et al. 1991). Initially, they produced metal tubes for cartridges and shells, and later light infantry armament. Until 1950 it was a military company, but later it started manufacturing equipment and parts for the building material industry, changing its name to *9 May Works*. (*Uzinele 9 Mai*). After 1990 it changed its name to *PUMAC*. In 1864, *Louis Lemaître* opened a foundry in Bucharest, which later became the *New Times* (*Timpuri noi*) factory (Manole et al. 1991). In 1891, the Lemaître works produced the first row seed drills. In 1898, the Lemaître works were transformed into the *Romanian Metallurgical Joint Stock Company* (*Societatea Anonimă Metalurgică Română*), and extended the production to stationary engines, threshing machines, steam engine activated mills, spray pumps, barometric vessels and pumps, public hygiene equipment, etc. (Manole et al. 1991). Figure 9 presents the department of stationary engine assembly. In 1948, the Lemaître works were nationalised and changed their name to *Fabrica Timpuri Noi*. The production profile was changed to compressors, pumps and assembly materials. The Swiss *Erhard Wolf* (who came to Romania in 1877) opened a foundry in 1886 (Manole et al. 1991). At first, he produced warheads for the Ministry of War, but then built a brass foundry for metal fittings (hinges and locks). He was the *first to build filling stations for steam locomotives* (Manole et al. 1991). In the 1900–1910 period he manufactured oil industry equipment, central heating equipment, metal railroad bridges, and also military equipment during the First World War. After the nationalisation, the company was divided into two factories: one for pumps (later named *Aversa*) and one for hydraulic equipment (later named *Red Star*). The

1887 Law for Encouraging National Industry stimulated the industrial development, including metalworks and machine building. Consequently, several companies and workshops emerged, such as: the *Weigel in 1889*, the *Haug in 1890* (producing iron works), the *Rășcanu foundry in 1900* and the *Botez Bodyworks in 1901* (Manole et al. 1991). *Abonyi*, a representative of the *Brünn-Königsfelder Maschinenfabrik* of Brno, founded in 1904 a branch of the company in Bucharest. In 1908, it became a joint stock company, one of the stockholders being the Romanian state, and took the name *Vulcan Society—Machine Factory (Societatea Vulcan – Fabrică de mașini)* (Manole et al. 1991). This factory started to produce *equipment of oil industry and tank wagons*. The main profile of the factory was to make boilers for various industries (oil, chemical, etc.) as well as lifts and compressors. The name and profile of the company were also maintained after the 1948 nationalisation (except for 1950, when it was called *Mao-Tze-Dun, MTD*). This is where the *first Romanian buses* called *MTD* were made in 1955. Beginning with 1984, the Vulcan factory produced parts for the Cernavodă Nuclear Power plant. After the Romanian state took over the railways built by foreign concession-holders (under the 1883 law), the *Grivița Railway Repairing Workshops were founded in Bucharest in 1897* (Manole et al. 1991). The reason why the workshop was founded was the maintenance of steam locomotives and carriages of the Romanian Railway Company (CFR). After the nationalisation in 1948, part of the Grivița CFR Workshops were transformed in the *Grivița Chemical Equipment Company*. This company became the main producer of equipment for chemical industry platforms in Romania. In 1899, the *FELD et BUDICH Device and Machine Production and Trade* company was established in Bucharest (Manole et al. 1991). The workshop specialised in making equipment for factories of food industry (canneries, distilleries, etc.). After several name changes (in 1906 and 1915), in 1930 it took on the name of *Paul Budich coppering and boilermaking works, device and machine factory* (Manole et al. 1991). In 1948, the workshop was nationalised and changed its production profile to equipment for chemical, petrochemical and food industry (pressure vessels, cooling columns, distilleries, heat exchangers, etc.). In 1973, it was renamed the *Mechanical Factory for Chemical Equipment*, and after 1989 it changed into a joint stock company with the name *Mechanical Company of Chemical Equipment UMUC Bucharest*.

The beginnings of commercial vessel building in Galați are reported as early as the beginning of the nineteenth century, following the Treaty of Adrianople (1829). In 1839, there is evidence of building five ‘commercial ships’ (Păltănea 1994, 1995). In 1867, the *Military Marine Arsenal* was founded in Galați. At the beginning, barges and flatboats were built there, and from 1907 military monitor ships built at the Trieste dockyards (then part of Austro-Hungary) were assembled here.

In 1870 the German firm Strousberg founded in Galați the Workshops of the Romanian Railways which produced equipment and parts for the railway network (Păltănea 1994, 1995). In 1887, the *Bee chemical factory and tin packaging company* was built in Galați, which produced packaging for the cannery that had been working there since 1844 (Păltănea 1994, 1995). In 1888, the first nails and wire factory called *Wolff et Comp* was founded, followed by some more factories in the same field (Păltănea 1994, 1995). Max Ausschnitt (Fig. 10) established in 1920 the *Titan Works*,

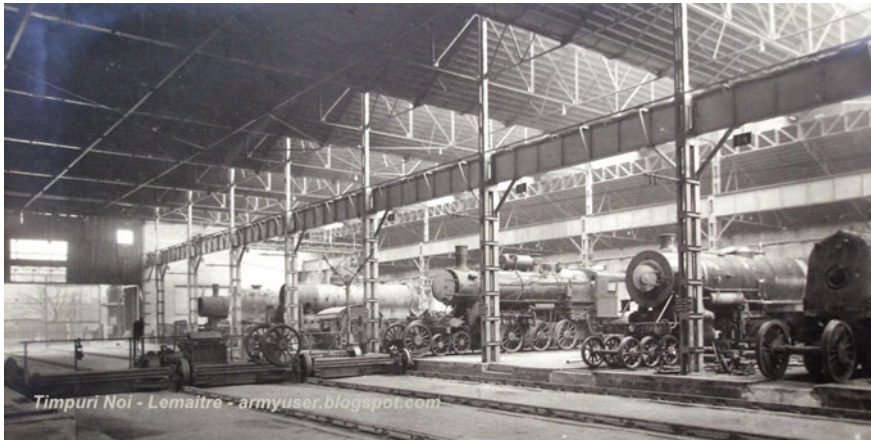


Fig. 9 The Lemaitre Works (1923) (courtesy of Dr. V. Wollmann)

producing hot rolled steel sheet, built upon the structure of his father's nail factory (founded in 1906). Later on, this factory extended to establish, in 1924, the *TITAN-NĂDRAG-CĂLAN SAR United Metal Works*, with the head office in Bucharest. After the nationalisation, the *Galați Titan Works* became the *Sheet Rolling Mill Company Galați*. *G. Fernic* established at Galați in 1893 the *Mechanical Construction Works and Iron and Brass Foundry*, which was transformed, in 1897, into the *Galați Dockyards* (Shipyards had been reported to exist in Galați as early as 1784.) (Păltănea 1994, 1995). *The first oil tank was built here in 1947*. After the nationalisation, in 1950, the dockyard merged with the former *Military Marine Arsenal*. It was then extended and technologically upgraded, allowing for the building of larger and more complex ships. In the period of 1974–1988, seven marine platforms for oil extraction were built at the Galați dockyards, the first of which was the *Gloria* platform.

In 1897, the *Giurgiu Dockyards* were established, mainly for repairing river ships. Someships representative for the Romanian fleet were launched on water here

Fig. 10 Max Ausschnitt



even before the establishment of the dockyards: *Romania—the first warship of the Romanian principalities, Ștefan cel Mare and Fulgerul.*

After the War of Independence of 1877–1878, when Dobrogea was attached to Romania, and its railroad network was connected to the Romanian one by the Saligny bridge at Cernavodă (inaugurated in 1895), the freight traffic via the port of Constanța increased considerably. Therefore the need emerged to build another *dockyard* in *Constanța*. It was founded in 1899 and functioned until 1962 as a ship repairing workshop. After this date it also worked as a ship building factory for oil tankers, bulk ships, etc. The *Independence* oil tanker was built at this dockyard in 1977, while in 1984 *the largest Romanian oil tanker* of 163,000 tdw, called *Victory (Biruința)*.

The development of the Moldavian railroad network made it necessary to establish repair workshops for locomotives, wagons and rolling stock in this part of the country as well (Pașcani in 1869, Galați in 1870, Iași in 1892). These, together with those of Constanța (1865) and Bucharest (1897), ensured the maintenance of the locomotives and wagons on the territory of the Romanian Kingdom. *The first such establishment* was in *Pașcani*, on the Roman-Suceava railway, founded in 1869 (Botez and Esanu 1970). Figure 11 presents this workshop. The Pașcani repair workshops rapidly developed, and both the number of employees and the technical level of the equipment and machines increased (Botez and Esanu 1970). The workshop in Pașcani continued its intense development even after the Second World War (when it got almost completely destroyed) and extended its profile, building freight wagons, ore transport wagons, and bogies.

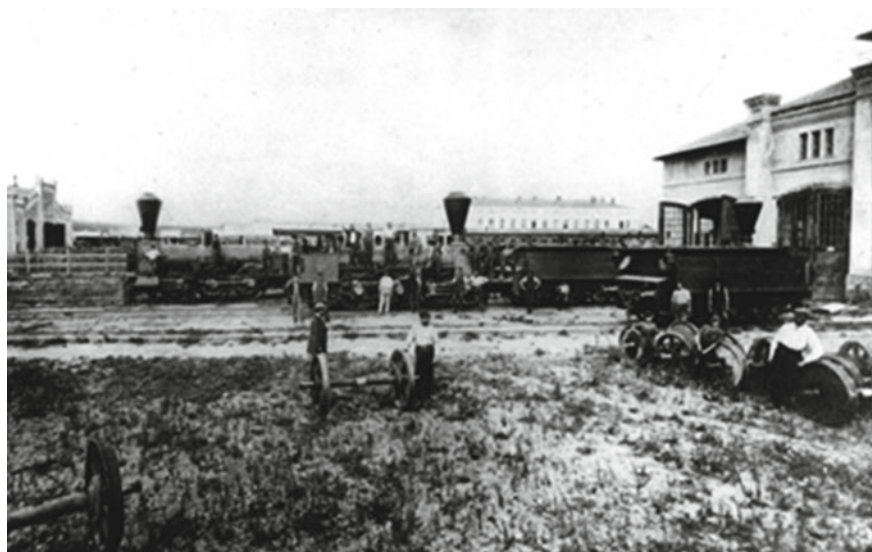


Fig. 11 Photograph from 1873 of the repair workshop of Pașcani taken by Károly Papp de Szathmary (Botez and Esanu 1970)

Due to the extension of the railway network, another repair shop for rolling stock was needed in this part of the country. Thus, in 1892, the *Frumoasa CFR Workshops* were established in Iași. This was the *first machine building factory in Iași*. (Botez et al. 1972). Later, in Păcurari-Iași, the *Vulcan SA* society was founded, specializing in repairing agricultural vehicles and equipment, and owning also a foundry and the *Biruința* factory. The production of wheels, assembly, etc. actually started in the *CFR Iași Workshops* only in 1905 (Botez et al. 1972). In 1921, the company changed its name to *Nicolina Iași CFR Workshops* (Botez et al. 1972). In 1967, the *Nicolina CFR Workshops* extended its production profile to building equipment and road building works (static and vibration rammers, asphalt mixture finishers, blade graders, front loaders, etc.) and changed its name to *Nicolina Iași Mechanical Works*.

Costinescu, a Romanian businessman, built a *factory for nails, screws and screw nuts* at Sinaia in 1892, as part of the *Emil Costinescu Company Sinaia*, transformed in 1913 into the joint stock company *Emil Costinescu SA*. In 1938, it started producing armament. After the nationalisation in 1948, it changed its profile and started producing equipment for precision mechanics, and beginning with 1953, also injection pumps for cars and tractors. The name of the company changed to *Sinaia Precision Mechanics Factory*.

In 1909, the *Petroșani Central Workshops* were built in order to provide mechanical and electrical repair services to the mines in the area. After the foundation of the *Romanian Joint Stock Company Petroșani*, they extend their business by upgrading their equipment. This is where Constantin Brâncuși cast the elements that compose the Endless Column.

In *September 1916*, the *General Reserve of the Aviation* was founded in Iași, by transferring the workshops existing in Cotroceni and Băneasa. This was the *first Romanian aeronautical industrial company in Romania*. Its role was the maintenance, repair and improvement of Romanian war planes. The factory functioned in Iași until 1919, when it was transferred to Bucharest, changing its name to the *Bucharest Aeronautical Arsenal* in 1920. Captain Ion Gudju established here the first laboratory in Romania for studying and testing the materials used to build airplanes. The Aeronautical Arsenal built *three self-designed models of airplanes* before 1939: Brandenburg, Proto 1 and Aeron.

In 1864, Prince A I. Cuza's Council of Ministers decided to establish a *foundry for armament industry in Târgoviște*. The *Arsenal of Târgoviște* was inaugurated in 1872 in the presence of King Carol I. This factory produced cannons and cannonballs until after the Second World War. Later, in 1945, it changed its name to *CFR Workshops*, and became a machine and equipment building company. In 1950, the profile and name of the factory changed, and it started to produce drilling machines, equipment for geological surveys, etc. The name was changed to *Târgoviște Oil Equipment Company*. Beginning with 1960, the drilling equipment T50-B was produced here, a state-of-the-art machine for that time on a global level. The company specialised in this field, becoming an internationally recognized company in the field due to the quality of its products.

In Craiova the first workshop that produced and repaired agricultural machines was established by Mihail Nasta in 1878, as a branch of the British Clayton & Shuttleworth Company. In 1910, the *Brătășanu Workshop* was established, in the beginning as a repair shop for agricultural and industrial machines. After the nationalisation, the factory started producing modern agricultural machines for working large surface areas. The name of the factory changed to *Craiova Tractors and Agricultural Machines Factory*.

At Aiud, Alba County, a *locksmith's workshop* was established in 1894, transformed in 1931 into the *GENIUS Factory for Technical Articles*. After 1948, the workshop was nationalised and took on a new name, the *Rapid Factory Aiud*, and in 1951 it extended its profile to the repair of locomotives and wagons. In 1954, it changed the name again to *Aiud Metalworks*, and in 1958 started building machines and equipment for metalworks, ironworks and machine building industry, having been considered the *Chief Mechanic of Romanian Metalworks and Ironworks*.

The first factory of *Satu Mare* was founded in 1906 and named *Princz*. In time, the factory had repeatedly changed its name and production profile, and after 1948 it started producing household machines (especially gas stoves). The first Romanian gas stove was produced here in 1952. In 1911, the *UNIO* factory was established here, specialising in furniture manufacturing. After the First World War the factory changed its profile, producing freight wagons and carriages (*the first Pullmann type coaches in Romania*). After the nationalisation, the company changed its production profile and, after 1950, it started producing mining equipment (minecarts, conveyor belts with scrapers, ore loading machines, etc.).

Because of the developing oil industry in the Prahova region, a group of oil industrialists founded the *Drilling Repair Company in Ploiești* in 1908 (Pintilie 2007). Later, in 1913, it was transformed into the *Drilling Repair Company*, extending its profile to making reservoirs, pipes, faucets, etc. After the First World War, in 1922 it changed its name to *Ploiești Metalworks*, also manufacturing drilling and extraction equipment. It also extended to the field of the military before the Second World War, manufacturing *automatic anti-aircraft guns under Schneider licence* (Pintilie 2007). It was nationalised in 1948 and renamed the *May 1 Works Ploiești*, becoming the *main supplier of deep drilling equipment of the Comecon countries*.

The *Roman Mechanical Works (IMR)* was founded in 1916 as part of the Army Arsenal, specialising in military equipment. After the nationalisation in 1948, the company profile diversified, specialising in producing machine tools for wood processing, carousel lathes, overhead cranes, cranes, forklifts, etc. The *ONSAL Roman* (detached from the IMR) produced in 2013 *Europe's largest carousel lathe*, with the maximum diameter of the turning part of 17 m and weighing 450 tons (Fig. 12).

In order to examine the situation of the industry in Romania at the beginning of the twentieth century, the Minister of Agriculture, Trade, Industry and Estates initiated in October 1901 a census (industrial survey) of production companies which was carried out in 1901–1902. Its results and analysis were published in 1904 in two volumes under the title *Ancheta Industrială din 1901–1902 (The Industrial Survey of 1901–1902)* (** 1904). The first volume is dedicated to the major industry. The



Fig. 12 Europe's largest carousel lathe, produced at ONSAL Roman (Photo from the author's collection)

major industry, according to a law from 1887, meant the industry that comprised companies which met three conditions cumulatively: a fixed capital of over 50,000 lei, over 25 employees, and the use of modern machinery. The results of the survey showed that Romania had, in 1901, a total of 62,188 production units in the major and minor industry combined, with a driving force of 60,744 horsepower (HP), employing a number of 169,198 workers. In contrast, the processing industry (sawmills, metalworks, mechanical factories, glassworks, pottery, brickyards, cement factories) only comprised 127 factories with a driving force of 8,310 HP and employing only 10,990 workers. The textile industry included 49 factories with a driving force of 2,507 HP, employing 5,449 workers. The food industry included 35 factories with a driving force of 4,611 HP, employing 2,172 workers. The paper, cellulose and typography industry included 21 factories with a driving force of 4,783 HP, employing 2,587 workers. The chemical industry (including oil industry) comprised 51 production units with a driving force of 1,025 HP, employing 2,264 workers. The two electrical power plants operating in the period had an output of 4,800 HP, employing 60 workers. Another category were the companies which processed agricultural products (food industry: mills, distilleries and breweries). These comprised 126 items in all (86 mills, 28 distilleries and 12 breweries) with a driving force of 13,874 HP, employing 4,431 workers. The third category were the state or communal companies (tobacco factories, match factories, military factories, typographies, dockyards,

railway workshops, electric power plants, water power plants, etc.). These comprised 52 items with a driving force of 9,230 HP, employing 9,742 workers. The major industry comprised a relatively low number of companies, only 471, with a driving force of 49,140 HP. It employed 37,695 workers. The data analysis shows that the major industry only accounted for less than 1% of the production units but had an installed power of 80%. The major industry employed over 22% of people working in industry. The analysis also proves that *at the beginning of the twentieth century the Romanian industry was primarily based on minor industry (manufacturing), with a low technical capacity (less than 20% of the driving force—steam engines, internal combustion or electrical machines) and employing 78% of people working in industry*. An excellent analysis of the data of the Industrial Survey from 1901–1902 was published by N. I. Păianu in his work *Major Industry 1866–1906* (Păianu 1906).

Before the First World War, in 1914, there were 83 metal processing companies on the territory of Romania, with an installed power of 9,600 HP (Păianu 1906). Transylvania and Banat had an important contribution to Romanian industry after the 1918 Union (Table 1) (Popescu 1929).

The data presented in Table 1 displays a significant difference in the distribution of industry within the historical provinces of Romania, highlighting the very low prevalence of industry in Bessarabia. Taking into account strictly the metallurgy and machine building industry, the installed power of the factories of Transylvania and Banat was 57,836 HP of the total Romanian installed power of 86,714 HP, which means 66.5% (Popescu 1929). The geographical distribution of the extraction and processing industry of Romania after the Great Union of 1918 was very uneven across the country (Gusti 1939; Georgescu 1941; Malinschi 1964). These branches of industry were almost completely absent in Bessarabia and Moldavia, and strongly localised to some key areas: Banat, Central Transylvania, Bucharest and the Prahova Valley, as well as Galați and Brăila. The Great Romania formed after the Great Union of 1918 had to respond to two great challenges in the field of industrial development, both caused by the aforementioned inequalities: that of the major and minor industry, and the unequal geographical distribution across the country.

Table 1 The distribution of driving force of industry in the Romanian provinces (Popescu 1929)

Province	Horsepower (HP)	No. of inhabitants per HP
Transylvania and Banat	210,115	26
Bucovina	20,640	39
Wallachia and Moldavia	171,340	46
Bessarabia	9,580	302

2 Machine Building Industry in the Interwar Period

The Great Union of 1918, which resulted in the annexation of Transylvania, Banat, Bucovina and Bessarabia, had a significant impact on the social and economic life of Romania. The Malaxa Workshops were founded in 1921, specialising in locomotive repairs. Drawing on the provisions of the law for the encouragement of industrial development, Nicolae Malaxa (Fig. 13), an excellent engineer trained at the Technical University of Karlsruhe, Germany (currently the *Karlsruher Institut für Technologie*) and a visionary entrepreneur, began building a factory for railway equipment in 1923. In 1928, he started making steam engines, railcars, carriages, Diesel engines, etc. At that time, the Malaxa Factory was Europe's foremost rolling stock factory and of the most modern ones from an architectural point of view (Fig. 14). In 1928, the first steam engine was built there. Between 1932 and 1934, locomotives went into production, and in 1931 the first Diesel locomotive was built. It took over the novelties of the field in a very fast pace, proved also by the fact that in the period of 1934–1940 seven generations of railcars were designed and produced at the factory. Malaxa used a revolutionary patent of Gogu Constantinescu in railcar building, called the *Sonic Couple Convertor*. This patent was used for the first time in the world for the building of locomotives at the Malaxa Factory. Consequently, Romania did not have to import any locomotives after 1930. In 1939, the most powerful steam engine in Romania was built here (Fig. 15). After the 1948 nationalisation, the factory became the *23 August Factory*. In 1938, Malaxa established, as a part of the rolling stock factory, the factory of artillery ammunition and armament, producing, in addition to artillery ammunition and armament, tankettes as well (designed also group). In the same year the production of optical equipment for military use also started. It also produced tanks under Renault licence. In 1938, Malaxa also built a factory for making seamless pipes, which was later renamed *Republica*. This factory was, at the time of its inauguration, the most modern factory of laminated pipes in Europe, using the American Stiefel lamination method for the first time on the continent. When pipe production for oil industry was at its best, this factory was the fifth largest producer of seamless pipes in the world. Beginning with the 1970s, the factory started producing parts for the Cernavodă Nuclear Power plant. In addition to the factories in Bucharest, including IOR Bucharest (Romanian Optical Industry), the Malaxa concern also included factories in different locations throughout the country: the Astra Arad, Unio in Satu Mare, the Tohan Factory of Zărnești (founded in 1938 for making bicycles, and later artillery ammunition). The UDR Reșița built in 1945 the Malaxa car, which was the first Romanian-designed automobile. It can be said that in the period 1921–1945 Malaxa managed to build an industrial complex for Romanian machine building, which became the main pillar of Romanian industry between the two World Wars. What's more, it was considered one of the great industrial complexes of Europe as well, as an example for a successful use of national capital. The words of one of Malaxa's collaborators are meaningful: *'He was the man and engineer who had the courage, skill, and patriotism necessary to demonstrate to the world the*

industrial vocation of the Romanian people, considered by foreigners to be nothing but ploughmen and shepherds’.

In 1923, the engineer Grigore Zamfirescu founded in Bucharest the *Society for Technical Explorations*. This was *the first airplane building company in Bucharest* (Manole et al. 1991). At the beginning, the company repaired and maintained the military aircrafts of the Romanian army, then it started to modify the bombing planes, and in 1926 it started to design and produce its own airplanes. In 1927, the *Proto-SET* model was built, and in 1928 the *SET-3*, later starting the production of the latter.



Fig. 13 Nicolae Malaxa, the founder of modern national industry

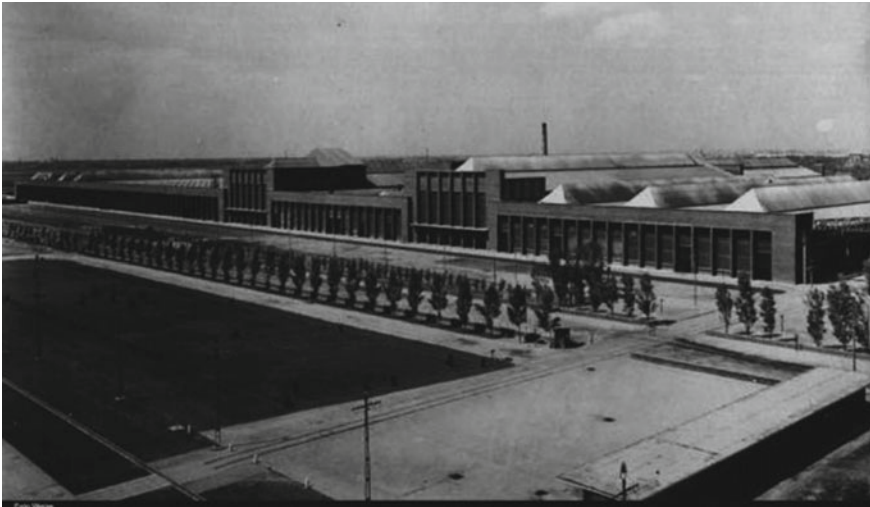


Fig. 14 The Malaxa Factory in 1933 (design by architect Horia Creangă) (courtesy of Dr. V. Wollmann)



Fig. 15 The most powerful steam engine in Romania, produced by the Malaxa Factory in 1939 (Photo from the author's collection)

In 1931, the SET changed its name to *Grigore Zamfirescu Airplane Factory S.E.T. (Fabrica de avioane S.E.T. inginer 'Grigore Zamfirescu')*, and developed production by designing and making new airplane models, especially for military industry (Manole et al. 1991). In 1953 the factory upgraded its technology and changed its profile to the production of measurement and control devices, renamed to *Precision Mechanics Company*.

The Ford Factory of Bucharest was established in 1935 under the name Ford Romania SAR, with the purpose of producing car body parts and to repair automobiles. This was where the *Ford V8 Fordor Sedan* car was built. In 1948 the factory was nationalised and closed down. In 1926, the *Leonida Workshops* were established in Bucharest. At first, it was a *truck assemblage shop, the first of its kind in Romania*. Later it became the Romanian representative of the *General Motors*, changing its name to *Leonida S.A.R.* (Manole et al. 1991). In 1921, the *Fichet Factory* was established (Manole et al. 1991) which built safe boxes, cash registers and other steel sheet products. In 1949 the *Semănătoarea Factory* was built on the structure of the former. In the first period of its existence it produced trailed harvesters and sowers, and after 1955 it moved to a different level, producing trailed combine harvesters and precision sowers. Beginning with 1969, it started producing self-propelled combines, the first of these being the *Gloria C12*. This was a great success for Romanian agriculture, as it greatly increased the productivity both for straw cereals and corn harvest. In 1936, the *Romanian Optical Company IOR* was founded in Bucharest, as the first Romanian factory that produced optical equipment. During the war, in 1941, the

company started to produce military equipment (binoculars, telescopes, telemeters, etc.). After the nationalisation, beginning with 1949, this is where the first eyeglass lenses, the first didactic microscope (1951) and the first Romanian photo camera called OPTIOR (1954) were produced. Later the production extended to the field of medical equipment for ophthalmology (1959), equipment for dentist's offices (1961), binocular microscopes (1960) and research microscopes (1962), cinema projection equipment and camera lenses (1967).

In 1920, a joint stock company was founded in Câmpia Turzii (Ghiriş) with the name *Wire Industry*, which produced dead-drawn wire and nails. After it was nationalised in 1948 it changed the name to *Câmpia Turzii Wire Industry Factory*.

The *Romloc* company was founded in Braşov in 1921, as a locomotive and wagon repairing workshop. In 1935, the *Astra Wagons Arad* company extended its activity to Braşov, on the Romloc territory. In 1938, Romloc changed its profile to armament production. After 1948, the factory was renamed **the Red Flag (Steagu Roşu)**. In 1953 the *Steagu Roşu* factory produced the first Romanian truck, SR (Steagu Roşu) 101, while in 1958 the first lorry, SR-131 Carpaţi, and at the beginning of the 1960s, the SR-114 Bucegi were built. In 1978, the factory reached its production record of 30,000 lorries, and a number of 26,000 employees. In 1922, the *Dumitru Voinea Machine Factory and Foundry* was established in Braşov for rolling stock repairs. In 1936 the factory changed its name to D. Voinea Metalworks S.A.R. Braşov, and started producing military technology (Brandt grenade throwers), becoming one of the main Romanian weapon producers. After 1965 it changed its profile and produced carburettors, oil and diesel filters, oil, fuel and water pumps, becoming the main supplier for the Romanian car and tractor industry. The Romanian-Austrian *Farola* company was also founded in Braşov in 1923, manufacturing wire, steel sheet and copper cables for the engines of railway equipment. In 1935, the *Metrom* factory was established, which, beginning with 1938, produced steel sheets, tapes, strips, bars, formed panels, copper and copper alloy tubes. *The airplane production in Braşov began in 1927, under Morane-Saulnier licence*. Engineer Elie Carafoli together with Lucien Virmoux, French engineer and technical counsellor at the IAR, designed the first Romanian fighter jet called *IAR C.V.-11*. It was built and tested in 1930. It was a monoplane with low wings, considered to be one of the best aircrafts of its category in the world. The design and production of new airplanes continued throughout the years with types IAR-16, IAR-39, IAR-80, and IAR-81, and the research aircraft IAR-47. *In 1928, the IAR started the production of airplane engines. The first mass-produced engine of Romanian design was the IAR-K-9, with a performance similar to foreign models, produced in 1937*. Figure 16 presents an overview of the IAR factory in Braşov from 1932 (Stoica and Antoniu 2020).

The *Benker&Jickeli Machine Factory and Iron Foundry* was established in 1920 (<http://patrimoniul.sibiu.ro/istorie/industrie/38>). In the interwar period it produced machines and parts for the textile industry. After the 1948 nationalisation, the factory changed its name to *Sibiu Metalworks*. Beginning with 1961, the factory's profile was the production of pressing machine tools. In 1965, the factory changed its name to *Sibiu Mechanical Company*, and it had continuously diversified and extended its production profile before 1990. At first, it produced a large variety of hydraulic

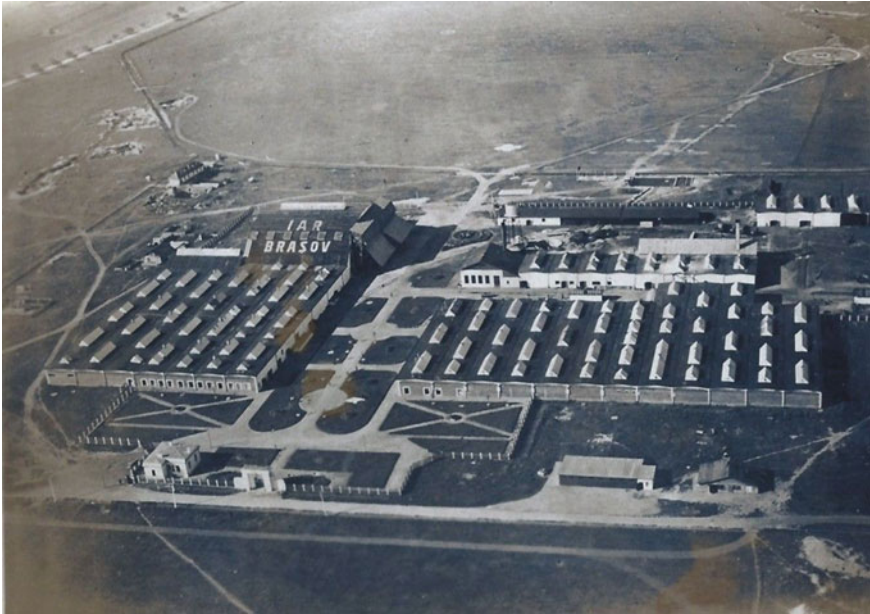


Fig. 16 Aerial photograph of the IAR factory in Braşov-1932 (courtesy of H. Stoica)

presses for cupping, sheet bending presses, plastic extrusion machines, precision cutting presses, etc. The GRATIOZA company, which was founded in Sibiu in 1922 with Austrian capital, produced envelopes and paper as well as parts and equipment for paper factories. After the nationalisation it changed its name to *Flamura Roşie State Industrial Company*, becoming the largest producer of office and school supplies in the country. *This was the first company in the country to make plastic products*. After 1960, it also produced plastic processing machines first for utility vans, then also for sales, and extended production also to equipment for the textile industry.

In 1921, the *Westen Modeling and Enameling Works* was founded in Mediaş, as *the first Romanian factory to produce enameled pots for household use* and other sheet products. It was nationalised in 1948 and renamed *Red Enamel (Emailul Roşu)*, maintaining its production profile and becoming the largest Romanian producer of kitchen supplies made by pressing. The *State Aeronautics Workshops* were founded during the Second World War (in 1941) in Mediaş for the repairing and maintenance of airplanes. After the nationalisation, it changed its production profile to a car repair company, and successively changed its name as well to *Central Car and Tractor Repair Workshop* (1957), then *Automechanics (Automecanica)* (1962).

As a result of the union of Transylvania and Romania and the new political, judicial and economic situation, the Romanian industry of Transylvania underwent a full reorganization. The same happened in Cluj as well, with many new companies, mainly joint stock companies (SA) appearing especially in the field of metallurgy and

machine building. The Orion company, founded in 1924, made household products. After the nationalisation, it changed its name to *Red Metal (Metalul Roșu)*. It became a producer for equipment and machines for food and textile industries. In 1929, the *RAVAG Metal Industry SA* was founded, which after the nationalisation became the *Armature (Armătura) Company*. The new company's production profile was sanitary fittings of non-ferrous materials.

Timișoara in the interwar period had more than 10 workshops and factories specialised in machine building. The most important of these were: *The Mecher Sheet Factory* (sheet products), *the Herman Scales Factory* (scales, bascule bridges, weighing machines), *Marki Workshop* (industrial repairs), *Friedrich Brothers Machine Factory and Foundry*, *Dura SA Factory*, *Jakabffi Cash Register Factory*, *Fabrica de lanțuri 'Timișoara' S.A. (chain factory)*, etc. (Munteanu and Munteanu 2002).

The *French-Romanian Company for Railroad Materials SA* was founded in Brăila in 1921. The company was initially founded as a locomotive repair workshop. In 1940, it merged with the Phoebus company of Oradea. In 1948, the company was nationalised and renamed the *Progress Heavy Equipment Factory Brăila*, including the production of machines used in constructions. It was here that the *first Romanian cable excavator was built in 1952, and the first compression roller in 1953*. Later on, the production got more diverse, it produced excavators, vibrating roller compactors, crushers, vibrating plates, bulldozers, etc. In 1972, it produced the *first hydraulic excavator* (under Liebherr licence), in 1980 *the first telescopic arm excavator*, in 1987 *the first electrical excavator, tracked excavators*, etc. The experience gained in the process led to the production, in 1974, of *the largest speed reducer produced in Romania*, weighing 80 tons and 6 m high, made for the Galați Steelworks. Also after the First World War, in 1923, the *David Goldenbers and Sons* company was founded in Brăila, producing *drawn wire, nails and metal products*. After 1927, other products were made as well, including chains, screws and screw nuts. In 1931 a rolling mill was built for making wire and reinforced concrete. The company was bought by Max Ausschnitt in 1933 and joined the TITAN-NĂDRAG-CĂLAN consortium. In 1938, it was renamed the *Danube Metalworks (I.M.D)*. In 1930, the Wire Industry company of Câmpia Turzii built the first wire rolling mill in Brăila. Both companies were nationalised in 1948 and worked independently until 1959, when they merged under the name of *Brăila Rolling Mill*. The factory grew continuously, making rolling mills for various sizes and shapes of profiles for the entire range of profiles necessary for machine building industry.

In 1937, the *Mărgineanca Factory* was established in Plopeni, Prahova County, to produce *ammunition*. After the nationalisation, it extended its production profile to civil industry products: bearings, parts for oil industry, pumps, engines and hydraulic cylinders for vehicles and machine tools, etc.). The *Plopeni Mechanical Works* was one of the *most important producers of armament in Romania*, reaching a number of 19,000 employees before 1990.

In 1938, there were 366 machine building companies in Romania, with an installed power of 152,100 HP, representing 10.2% of the global industrial production value (after food and fuel industries) (Gusti 1939; Georgescu 1941; Malinschi 1964; *** 1940, *** 1941; Constantinescu 1997).

3 Machine Building Industry in the 1948–1990 Period

The 1944 occupation of Romania by the Soviet Union marked the beginning of a nationalisation process of all companies on the territory of the state. In order to pay the war compensation to the USSR (which amounted to 300 million dollars, i.e. 55% of Romania's national income in 1945), there started a process of transferring certain production lines to the Soviet Union (such are the cases of IAR Braşov, some tobacco factories, steelworks, typographies, etc.). In 1948, the main companies of Romania were nationalised ('individual businesses, companies of all kinds, and private industrial associations'), with 20 companies of steelworks, non-ferrous metalworks, and rolling mills, and 115 metal processing companies, dockyards, precision tools and electrotechnical material producers, and car repair workshops (***) 1948). Several companies with equal mixed Romanian-Soviet capital were founded in the 1945–1956 period (the so-called Sovroms) in the most profitable fields of industry. These companies had the purpose of facilitating and controlling the payment of war compensations. It has been assessed that over 30 billion dollars at the present rate were paid to the USSR. This led to the exhaustion of the country's natural and financial resources (strongly affected because of the war) and to a drastic fallback of industry, which decreased 45% compared to the 1941 production. The solution of the Romanian governing party (borrowed from the Communist Party of the USSR) to stimulate the economical growth of the country was to introduce a central stage-based planning (the so-called five-year plans). The first five-year plan was implemented in the 1951–1955 period, and the system was in place until the fall of communism in 1989. Before 1951, the Romanian economy was planned on a yearly basis. When the five-year planning was introduced, the reconstruction of Romanian economy was coordinated by a State Planning Committee. The five-year plans stipulated huge investments in industry, mainly in heavy and chemical industry. Two industrialisation periods can be distinguished for the 1945–1990 period: the first before 1965, and the second after 1965. The first period is characterised by rebuilding the Romanian industry, subordinated (especially in the 1950–1960 period) to the economical and political interests of the USSR. The second period after 1965 was characterised by the principles of multilateral development (first and foremost of steelworks, chemical industry, oil industry and machine building) and equal geographical distribution. Consequently, in 1989 the proportion of industry in the GDP was 46.2%. The intense industrialisation process led to a significant rise in the number of industrial companies, from around 1,000 units in 1945 to 1,568 in 1965, and 2,102 in 1989. In the same period the total industrial production of the country increased 44 times. In

what follows, the history of machine building will be presented according to the two historical stages, distinguished mainly by their investment priorities and the criteria behind these investments.

3.1 Machine Building Industry in the 1945–1965 Period

This period is defined, on the one hand, by the technological upgrading of companies founded before the Second World War, and on the other hand by the establishment of new machine building companies in the areas where machines and equipment were lacking (chemical industry, heavy machines industry, steelworks, vehicle building, food processing, etc.). The following pages present the main companies in the field of machine building founded in the 1948–1965 period in the chronological order of their foundation. In 1946, the production of the *IAR Braşov* factory was changed to *tractor production*. The *first Romanian tractor*, *IAR 22*, was built in the same year. The IAR was closed down the next year and the factory was renamed the *State Metalworks*, and later (1948) the *Tractor Plant Braşov (UTB)*. The first tractor designed completely in Romania was produced beginning with 1960 (U650). IN 1990, the factory had 23,000 employees and produced 50,000 tractors, more than half of which was exported. The *Sinterom* in *Cluj* was founded in 1948 as the nationalised *Triumf* company, established in 1936 for making chemical products. After the nationalisation it changed its production profile, making spark plugs for engines. One of the first companies established after the Second World War was the *Electroputere Craiova*, founded in 1949. At first, it produced high power energetic equipment, and from 1960 it moved from the production of diesel-electric locomotives to electric locomotives (from 1966), under licence of the Swedish ASEA company and cooperating with the Reşiţa Machine Building Factory for the mechanical part. In the course of time it also produced electric railcars. The *Tehnofrig* company was founded in 1949 and used the equipment of the Hungarian industrialists of *Cluj*. It produced machines and technological equipment for food industry and refrigeration installations. In 1949, the *IMATEX* Textile Machine Company was founded in Târgu Mureş which produced automatic looms, winding machines, etc. In 1952, the *Metalotehnica* Company came into being, specialising in the production of machines and equipment of knitwear industry, industrial sewing machines, etc. The *Arad Lathe* Factory was established in 1949, as a merger of several factories and workshops. Later it took on different names (*Iosif Rangheţ Plant*, *the Lathe Plant*, *the Arad Lathe*), and extended to nearby areas with departments in Lipova and Chişineu Criş, Arad County. In 1951, the *Victoria watch factory* was founded in *Arad*, the *only factory of its kind in Romania*. It produced over 1 million watches before 1990. In addition to watches, the *Victoria* Factory also produced mechanisms and parts of precision mechanics for Romanian industry. The building works of the Danube-Black Sea Canal started at the beginning of the 1950s made necessary to build also a repair shop for the building equipment used at this construction site. The workshop was built at *Medgidia* in 1951. In 1958, after the construction of the canal was given up (1955), it was extended

and started producing trailers and agricultural machines under the name *Medgidia Mechanical Equipment Factory (IMUM)*. *The first independent bearing factory of Romania was established in Bârlad, Vaslui County, in 1951: the Bârlad Bearings Factory.* (Bearings were also produced in Braşov, but as a department of the Steagul Roşu Lorry Factory.) The production of bearings, using a Russian technology, began in 1953. The factory developed in time and extended production by diversifying the size and construction range of the products (from 4 type-dimensions to over 13,000). The *Airplane Repair Plant* was established in *Bacău* in 1953. It was a military-type company. Later it changed its name to the *Airplane Repair Company* (1970), the *Airplane Company* (1978), and in 1991 it turned into a joint stock company with the name *AEROSTAR SA Băcău*, producing, repairing and modernising military aircrafts and producing and repairing hydraulic aviation equipment. Also in 1953 the *Tudor Vladimirescu Company* was founded in *Bucharest*. It produced threshing machines for cereals and freight trailers. The first *TV-type* (Tudor Vladimirescu, the name of the factory) bus was produced there in 1957. Later the plant changed its name to *Autobus Plant* and produces buses, trolleybuses (1957), minibuses, coaches and utility vans. The *Mangalia Military Dockyards* were established in 1956 to *build military ships*. The *Drobeta-Turnu-Severin Freight Wagon Factory* was founded in 1956 and became one of the largest rolling stock producing factories in Romania. The *Electromureş of Târgu Mureş*, founded in 1957, *produced mechanical calculators*. Later, the production profile of the company extended and included electric heating products (electric heaters, electric hotplates, irons, etc.) and, from 1970, electro-mechanic calculators and cash registers for shops. In 1959, a part of the the Red Flag (Steagu Roşu) Plant of Braşov was detached, and it became an independent factory called *Bearing (Rulmentul) Factory*, one of the main suppliers of bearings for Romanian industry. In 1960, the *Mechanical Factory for Mining Machines and Equipment (IMUM)* was founded in *Baia Mare*, specialising in the production of *equipment for mining industry* (floaters, filters, crushers), building materials, metalworks and chemical industry. The *Steelworks Constructions and Fixtures Company (ICMSG)* was founded in *Galaţi* in 1960 in order to provide materials for the construction of the Galaţi Steelworks Company, one of the major industrial investments of Romania (a construction started in 1962). Due to the development of wood and paper industry in Suceava, it was necessary to establish a factory for the repairing and maintenance of mechanical equipment. Thus, the *Suceava Regional Factory for Maintenance* was founded in 1963. Later it changed its name to *Suceava Mechanical Factory (IMS)* and extended its profile to metal constructions. In 1980, IMS was transformed into the Suceava Machine Tools Factory (IMUS), focusing mainly on the production of heavy duty parallel lathes, drilling machines, band saws and circular saws, aggregate making machines, etc.

The Bucharest Heavy Machines Factory (IMGB) was founded in 1963 to produce large forged parts, chipped processing, etc., needed in metalworks, hydroelectric and thermal industry and later nuclear industry (Babici 2017). When Romania started its nuclear programme with the introduction of technologies from the US (General Electric) and Canada (the CANDU technology), it opened the way to the processing of very large and extremely heavy parts (up to 400 tons) through pressing and forging.

This was a real challenge for the machine building industry of Romania. IMGB was the main pillar for processing of such parts. Based on the IMGB's experience in making large forging presses, in 1978 they started the production of the 120 MN (12,200 force tons) press, which was finished by the end of that year. In order to manipulate the semi-products of 400 tons on the forging press, special manipulators were needed. Such a manipulator was designed and produced at the IMGB as well. The manipulator and the 120 MN press were the most complex pieces of equipment produced in Romania for the metal processing industry, placing Romania as one of the top three countries in the world to have such technology. Figure 17 presents the 120 MN press and manipulator for forged parts. The IMGB also produced other large parts, like crankshafts, transmission shafts, and rudder spurs for heavy ships. One of the parts made for metal processing industry worth mentioning is the continuous casting installation for the Galați Steelworks (Fig. 18). *One of the most complex products of the Romanian industry was the main circulation pump of the nuclear reactor of the Cernavodă power plant.* These pumps were only made in three places in the world, one of which was the IMGB. Figure 19 presents its structure and size. The mass of the pump's cast shell processed at final dimensions, was 125 tons. The *Machine Tools and Aggregates Factory IMUAB* was founded in Bucharest in 1963. The reason for the foundation of this factory was to make Romanian-built machine tools, high precision aggregates, and numerically controlled cars for machine building companies (Sandu et al. 2018).

3.2 Machine Building Industry in the 1965–1990 Period

In the period of 1965–1990, the machine building companies had their part in achieving Romania's strategic objectives. Such objectives were: the building of the Galați Steelworks, cement factories, chemical factories, hydroelectric and thermal power plants, modernisation of the factories of airplanes, locomotives, buses, lorries, tractors and agricultural machines, the building of Dacia Pitești and Olcit Craiova car plants, the building of Cernavodă Nuclear Power Plant, etc. The achievement of these objectives was a challenge for Romanian industry, requiring the combined and well coordinated effort of all actors involved. Therefore, a comprehensive industrialisation programme started, which claimed the construction of new factories or the technological upgrade and adaptation of existing ones. In order to better coordinate the machine building companies, and to achieve the strategic objectives of Romania, industrial centres were built which comprised several factories and research and design institutes with identical or similar profiles. The strategic objectives to supply machines and equipment for the various branches of economy were: making use of the country's natural resources and raw materials especially with regard to oil and gas, coal, ferrous and non-ferrous materials, building materials and wood; the development of the electric power supply to support this rapid industrialisation agenda, based mainly on Romanian raw materials (coal, gas, uranium), and making the most of the country's hydroelectric potential; the development of agriculture and food industry by

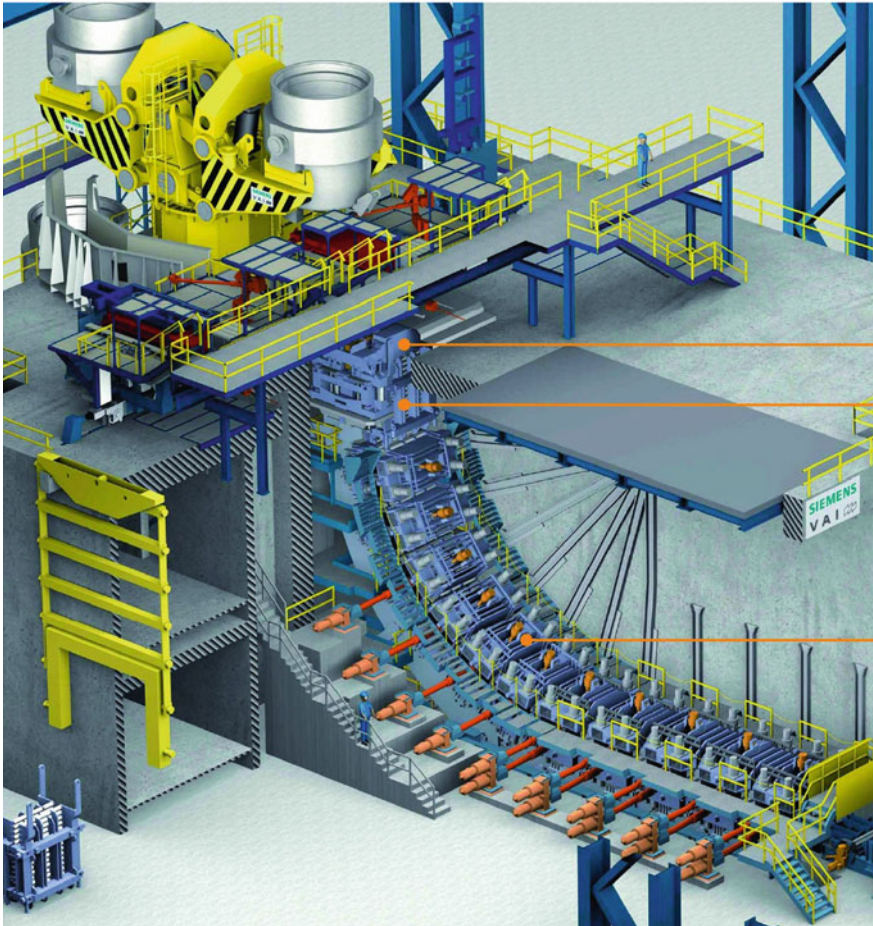


Fig. 17 A 120 MN press and forged parts manipulator produced at IMGB (Babici 2017)

the mechanisation of production, the irrigation of areas with water deficit (Bărağan, the south of Moldavia, Dobrogea, Oltenia, Banat), the industrialisation of Romanian agricultural products; the development of new branches or processing industry, especially metalworks and petrochemistry; the development of building materials in order to supply the materials needed for the construction of these establishments, especially cement; the support of the development of transportation, mainly road and railroad transportation, but also water transportation by river and sea; the development of fields of processing which had a high rate usage rate in machine building (electrotechnics, electronics, precision mechanics, aviation and military industry); the development of light industry and the branches of consumer goods industry.

In what follows, the establishment and development of companies in the various branches of machine building industry will be analysed for an easier and more



Fig. 18 The continuous casting installation made by IMGB for the Galați Steelworks (Babici 2017)

coherent presentation of the industrialisation process of this period. The first *machine tools* were produced in Romania since the interwar period in factories with a technology high enough to build such equipment. The first machine tools (lathes, drilling machines, milling machines, presses) were produced by these factories for their own equipment. Such examples are presented in the previous chapters: the ASTRA company of Arad, the Schiel company of Brașov, the Zamfirescu workshops in Bucharest, etc. After 1945, some companies specialised in producing machine tools in order to sell them. In 1965, there were just a few companies in Romania which produced machine tools, some of them built on the structure of other companies founded before 1945 [the Cugir Mechanical Works, the Sibiu Mechanical Works, the Brotherhood (Infrățirea) company in Oradea, the Arad Lathe Company, the Roman

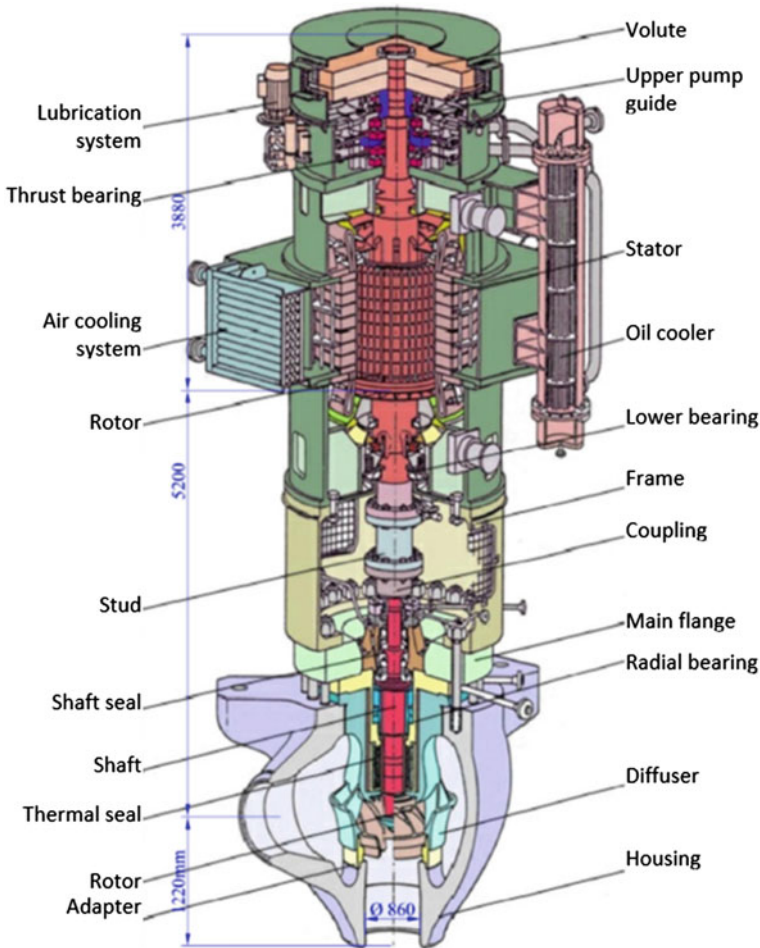


Fig. 19 The main circulation pump GTN 195 M of the 1,000 MW group of Cernavoda Nuclear Power Plant (Babici 2017)

Mechanical Works], others founded after 1945 (the Bucharest Machine Tools and Aggregates Company, the Suceava Machine Tools Factory). In order to catch up with other countries more experienced in this field, documentation and licence agreements were signed with companies from Germany, France, Italy, USA, Japan. A large number of machine tool factories were founded in this period, specialising in different types and sizes: The SARO Târgoviște Lathe Company (1969); Bacău Machine Tools Company (1971); Alba Iulia Mechanical Works (1972); Blaj Company for Machine Tool Accessories (1972); Electrotimiș Company Timișoara (1973); The Mechanical Rectifier Factory Cluj-Napoca (1973); the Iași Factory of Machine Aggregates and Special Machine Tools (1974); the Craiova Heavy Equipment Company (1975); Factory of Machine Tools for Pressing and Forging IMUPF Târgu Jiu (1975); Baia

Mare Machine Tools, Accessories and Tools (1977); Machine Aggregates and Parts Company (IMASA) Sfântu Gheorghe (1977); Dorohoi Heavy Machine Tools for Plastic Deformation Processing Company (1979), etc. In addition to these machine tool factories, the industry of tools and devices was also developed and new factories were founded: the Râșnov Tool Factory, and the Brașov Tool Factory presented before. The Focșani Device, Dies, Moulds and Cutting Tools Company was founded in 1971 (Sandu et al. 2018).

In order to support the objective of raw material usage, the industry of mining equipment and machines especially for surface mines was also extended and developed. For surface mines, large capacity system equipment was developed. Apart from large capacity transporters, other equipment was also designed and produced in the country, at the Mârșa Mechanical Works: 25 tons, 50 tons and 100 tons dump trucks, built with the American WABCO technology. The Faur Company Bucharest designed and produced mine gallery drilling machines, used both in mining industry and for building the underground in Bucharest.

The *metal processing industry* witnessed explosive development in this period, which needed to be supported with *adequate equipment*. The objective of the metal industry was to reach a production of 13 billion tons (starting from a yearly approx. 2 million tons in the 1960s). In order to achieve this objective, the Romanian machine building industry had to assimilate a complex range of metalworks equipment. For this reason the older steelworks, like those of Reșița, Câmpia Turzii, Oțelul Roșu, Brăila, were modernised, and the newer factories at Hunedoara, Galați and Călărași were developed. Equipment for furnaces, steelworks, coking, rolling mills, continuous casting machines, heavy presses for adjusting high capacity heat treatment furnaces were also produced. The main producers for metalworks equipment were Reșița, Faur Bucharest, Progresul Brăila, the Heavy Equipment Factory of Cluj and Iași, and a series of other factories in their horizontal industry (Sandu et al. 2018).

In the 1980s, Romania was the third producer in the world in the field of oil industry equipment. It supplied the whole range of drilling and instrumentation equipment from geological drilling to deep drilling for oil and gas. These were produced at the May 1st Factory Ploiești, the Oil Industry Equipment Company from Târgoviște, and the pumps at the Vulcan Plant in Bucharest. In 1976, a new plant was built in Giurgiu, the Machine Building and Heavy Equipment Company (Antonescu 2018).

After 1950, and especially after 1965, an extensive construction programme started for building a chemical and petro-chemical industry in Romania. The chemical equipment and machine building companies had a crucial role in this programme. In addition to the factories with a history in the field (like the Grivița Chemical Equipment Factory in Bucharest, the May 1st Factory in Ploiești), new companies also had to be founded for various fields of chemical industry. The Technological Equipment Company in Buzău, the Chemical Equipment and Forging Company of Râmnicu Vâlcea, etc. were founded at this time (Ivănuș 2016).

In the field of the *development of the electric power supply*, the machine building industry had to make the four types of equipment for *thermal power plants*, for *hydroelectric power plants*, for *nuclear power plants* and the beginning of equipment production for the field of *unconventional energy resources*. The thermal power plant

programme started in 1965–66, when licences were bought from Alsthom France (330 MW plants produced at the Heavy Machines Company in Bucharest) and from Babcock Germany (the boiler of 1,000 tons of steam per hour made at the Vulcan Plant in Bucharest). The production of these required the adaptation of existing factories and the building of new ones. To achieve this new, ambitious programme, a new integrated industrial platform was needed. Accordingly, the IMGB heavy machine building industrial platform was built in Bucharest. This platform was a European-level accomplishment in the field of machine building because it brought together the newest European technologies for classical power plants and the American and Canadian technologies for nuclear power plants. The hydroelectric equipment programme was achieved at the Reșița Mechanical Works and some other companies in the Banat area (Caransebeș and Timișoara). The whole range of hydraulic turbines were produced here: Kaplan, Pelton, Francis, and horizontal turbines. Apart from turbines and generators, the entire set of hydromechanic equipment was made there: valves, dams, cofferdams, sluice gates, cranes for dams and sluices (Sandu et al. 2018).

In the field of *agricultural equipment*, an entire industry was built that could produce all the agricultural machines necessary for the mechanisation of agriculture. As a result of this programme, Romania was one of the top ten tractor producers of the world (with over 75,000 tractors produced per year). In addition to the Tractorul Brașov, which was developed and modernised, and became the main producer of tractors and parts, other new companies were also built and modernised: The Miercurea-Ciuc Tractor Company, the Craiova Tractor and Agricultural Machine Company, etc. The horizontal industry for tractors and agricultural machines also evolved, with new establishments in Codlea, Întorsura Buzăului, Rupea, Sfântu Gheorghe and Buzău.

Railroad equipment was produced in factories with a history, such as: The Faur Factory in Bucharest (Diesel locomotives, railcars), Electroputere Craiova (hydraulic and electric Diesel locomotives), February 16th Cluj Napoca (hydraulic Diesel locomotives), Arad Wagon Factory (railway and underground coaches), Drobeta Turnu-Severin Wagon Factory, Nicolina Mechanical Works Iași, and newly founded companies. Such companies were built after 1965 in several places in the country: Roșiorii de Vede Rolling Stock Mechanical Works, Balș Factory of Axles and Bogies, etc.

In the field of road transportation, the production concentrated to some large companies: Autocamioane Brașov (lorries and dump trucks), Mârșa Mechanical Works (high tonnage dump trucks), Automecanica Mediaș (cisterns for the transportation of liquids, vehicles for urban sanitation, special vehicles for constructions—concrete mixers), Timișoara Mechanical Works (refrigerator trucks, firetrucks). Buses, trolley buses and minibuses were produced at the Autobuzul Bucharest, and the underground coaches at the Arad Wagon Factory. The car industry evolved on two platforms: Pitești, for Dacia cars under Renault licence (beginning with 1966), and Craiova, for Oltcit cars under Citroen licence (beginning with 1977). At Câmpulung Muscel the IMS off-road vehicles were produced under Russian licence (beginning with 1957, and the ARO off-road cars since 1972). The automobile production of Romanian was integrated to a proportion of 85%, based on a strong horizontal industry producing parts or subassemblies.

The machine building industry also ensured the *building of ships* for river and sea transportation, and the oil platforms for oil extraction in the Black Sea. The main dockyards on the Danube were those at Galați, Brăila, Oltenița, Giurgiu and Turnu Severin, and on the Black Sea those at Constanța and Mangalia.

As for the bearing industry, there were six bearings factories with a total of around 20.000 employees before 1989, and a research institute in Brașov. *Romania was one of the top bearing producers at international level.* In addition to the factories built at the beginning of the 1950s, the Brașov Bearing Factory and the Bârlad Bearing Factory, new ones were also built: Alexandria Bearing Factory (1974); Suceava Bearing Factory (1979); Ploiești Heavy Bearing Factory (1979); Slatina Bearing Factory (1990).

The *assembly body industry* also underwent significant development, the existing factories of Brașov, Mediaș, Bacău and Cernavodă were modernised, and new factories were built at Târgu Secuiesc (1970), Botoșani (1975) and Sighetul Marmăției (1975).

The precision mechanics, watchmaking and measurement and control device industry also developed in Bucharest (Research Device and Equipment Company), Otopeni (Measurement and Control Devices Company), Bârlad (Pneumatic Elements and Measurement and Control Devices Company), Suceava (Measurement and Control Devices Factory), etc.

After 1968, it has been decided to increase production and production capacity of the *defence industry* for making armament in the country (over 70%) and become independent from Russian armament import. The list of products was enlarged, new products were made, raising the army's equipment standards. Licence agreements were signed and the efforts to design and produce new equipment based on local research were increased. The production of armoured vehicles, tanks, military trucks, infantry fighting vehicles, sophisticated armament and ammunition, new battleships both for river and sea, war aircraft and helicopters, military logistics, and many more. All this required, of course, a rapid development of production capacity along with the modernisation of factories like those of Plopeni, Zărnești, Sadu 1, Cugir, Brașov. New factories were built, like the Reșița Cannon Factory, the Moreni Armoured Vehicle and Fighting Vehicle Factory, the Tank Factory of the Four Plants in Bucharest, the Uzina 2 Plant of Brașov, etc. With partners from Yugoslavia, the Airplane Factory was built at Craiova, where the first war aircraft were made for the army. The airplane factories in Bacău and Codlea Brașov were modernised, the Bucharest Băneasa platform was built for short courier planes, as well as the Bucharest Militari platform plane engine and aviation equipment production. The Bucharest Turbomecanica Plant was founded in 1975 for the production of turbine engines for aviation and mechanical transmissions for helicopters. This continued the tradition of Romanian aviation in making airplane engines, which was interrupted for a long while, like the Viper turbo-engine under Rolls Royce licence, or the Turmo IV CA turbo-engine for PUMA helicopters under Turbo Meca licence. In 1980, the licence for the Spey double flow turbojet engine for the ROMBAC 111 aircraft was bought also from the Rolls Royce.

The Bucharest Airplane Company was founded in 1978 under licence of the British BAC company to produce the ROMBAC 1–11 airplanes, in the place of an aircraft equipment repair company founded in 1950. *The first airplane was completed in 1982 and flew on the Bucharest-Timișoara route.* Nine airplanes were built there before 1990 (and two more were under construction), after which date the production came to an end.

The number of factories which produced *consumer goods* (the washing machine and sewing machine factory at the Cugir Mechanical Works, household appliances for heating at Electromureș Târgu-Mureș), was extended and new factories were built, like the refrigerator factory at Găești, the household appliances factory at Curtea de Argeș, etc.

New factories were also established in the field of textile machine industry, in addition to old ones: *Electrotehnica Company, Târgu-Mureș (1965), Botoșani Equipment and Parts Company (1970), Lugoj Equipment and Parts Company (1974).*

The establishment of the *Heavy Equipment Companies* was a special moment in the history of machine building industry. The decision was made at the beginning of the 1970s, and implemented by the establishment of three such companies: at Craiova, at Cluj-Napoca, and at Iași. The *Craiova Heavy Equipment Company* was founded in 1975 for the production of heavy machine tools and technological equipment. The *Cluj-Napoca Heavy Equipment Company* was founded in 1976 for the production of equipment for chemical industry, metal processing industry (steel ingot manipulators, thermal treatment furnaces, casting equipment, rolling mill cylinders, rolling boxes), mechanical presses for stamping bodies, cutting presses, hydraulic presses, mechanical presses, stamping hammers, etc. In 1976, the *Iași Heavy Equipment Company* also began to operate. It produced equipment for metal works and nuclear power.

In what follows, some of the companies founded in this period will be presented chronologically, though not exhaustively, as the first mechanical works in their respective settlements, putting them on the map of Romanian industry. The establishment of these factories also had an extremely important social and economic impact in the respective settlements. In 1969, the *Cast Iron and Steel Industrial Fittings Company (IAIFO)* was established in Zalău for the production of industrial fittings and safety valves used in oil industry. The *Râmnicu Vâlcea Chemical Equipment and Forging Company* was founded in 1970 for the production of large parts by forging and/or stamping, specific to chemical, petrochemical and metallurgical equipment as well as energetic equipment. In 1981, the *Hydraulic Equipment Company* was founded in Râmnicu Vâlcea, which produced technically highly sophisticated proportional electro-hydraulic equipment (servovalve). The first machine building company of *Bistrița* was the *Factory of Equipment for Construction and Refractory Material Industry*, founded in 1971, and transformed in 1977 in the Industrial Company for Machine Building with a very large field of activity: the production of machines and equipment for construction and refractory material industry, machines and equipment for forging and foundry, equipment for metal works, etc. Based on this data, it can be said that *the machine building industry became a fundamental branch of national economy after 1965.* The following pages present the arguments supporting this claim. The machine building industry covered over 70% of the machines and

equipment required on the internal market, and it also had a substantial proportion of the Romanian export market. The field of machine building comprised over 220 industrial companies, employing almost 1,100,000 workers, which accounted for approx. 30% of the national income. Many of the new production capacities were placed in counties with a lower industrial development and with available workforce, but also in the proximity of the traditional industrial centres like Bucharest, Braşov, Ploieşti, Reşiţa, Galaţi, Arad. A local research and design base was created by the foundation of a network of research and design institutes both with departmental and product profiles (see Sect. 5). 20 industrial centres were organized, inspired by the organization and leadership systems of major Western industrial concerns as integrated units, comprising the productive plants with their own research and design institutes, technical training schools for their staff, possibilities for internal sale and direct export, and some of these organized as general suppliers for an entire industrial process. Each industrial centre worked by the principle of self-management and self-finance, with their very own investment, research and design programmes, export programmes, and their own technical, economic and management teams. The proportion of machine and equipment export reached almost 30% of the entire production; the products were exported to over 120 countries all over the world.

4 Machine Building Industry After 1990

After 1990, the machine building industry was affected by some major events: the transformation of state companies into business entities or autonomous public entities; the privatisation of commercial companies; the fall of the export market to members of the Comecon countries, the Arab and the African countries; globalisation, with the appearance and development of branches of some major international companies; the frontiers opening for foreign products; the rapid growth of interest rates. These events led to crucial changes in the Romanian industry, as the new companies had to function in a context which was utterly different from the pre-1990 one. As a result of the law on the transformation of companies into business entities, the state gradually withdrew from industrial activities, which meant the lack of financial support, consulting in strategic marketing and management, etc. All these events led to the collapse of the pre-1990 Romanian industry. The proportion of industry in the GDP decreased significantly in the 1989–2014 period from 46.2 to 25.2%, due to the collapse of some of the most important branches of industry, many of them also competitive on an international market. The forced industrialisation placed the economy under great strain, as it oversized some of the branches without having the necessary reserves of raw material resources. In the preceding period, especially before 1965, the norm was an industry with high energy and raw material consumption and intense use of an often poorly trained workforce. The development came to a halt because of the lack of modern equipment and computing, the failure to use foreign capital and the lack of economic competitiveness. Romania's re-industrialisation after 1990 happened, largely, through two mechanisms: buying,

restructuring and technological upgrade of Romanian companies by major players on the international market (Dacia-Renault, Daewoo, Ford, Damen, Timken, KOYO, etc.), or by Romanian investors with an entrepreneurial vein (Comelf Bistrița, Compa Sibiu, RAAL Bistrița); founding companies of foreign businesses in places where trained workforce was available (Schaeffler Brașov, Continental Timișoara and Sibiu, Star Transmission Cugir, Emerson Cluj) or in areas with cheap workforce which needed no special training (Leoni Bistrița and Târgu Jiu, Draexlmaier Satu Mare, Pirelli Slatina, Autoliv Onești, etc.). As regards the field of production, the Romanian machine building companies operate in some basic areas: *automotive industry*, *aeronautical industry*, *machine tools industry*, *agricultural machines industry*, *bearings industry*, *naval industry*, *railway industry*, *consumer goods industry*, etc.

5 Research and Design Institutes in the Field of Machine Building

After 1948, and even more so after 1965, a local research and design base was created by the foundation of a network of research and design institutes both with departmental and product profiles. The institutes with departmental profile were as follows: Technological Research and Design Institute or Machine Building (ICTCM) Bucharest; Hot Technologies Institute Bucharest; Welding and Metal Testing Institute Timișoara; Thermal Engines Institute Bucharest; Special Production Institute Bucharest; Design Institute for Electrotechnical and Electronic Industry Bucharest. In addition to these, institutes with product profile were also founded to conceive and test certain specific products (airplanes, vehicles, wagons and locomotives, energy equipment, bearings, agricultural machines, ships, etc.). These institutes primarily supported the companies of that particular production profile, ensuring expert assistance in the research, design and testing of the products made in these companies. The institutes of this network provided a strong technical know-how, being equipped with research and testing laboratories. Almost all of these institutes closed down after 1990 or significantly reduced their activity, this way a huge amount of expertise accumulated in decades of experience has been lost. Research and development centres were established also after 1990 by many multinational corporations established in Romania: RTR Bucharest and Titu, Continental in Timișoara and Sibiu, Bosch in Cluj, Autoliv in Brașov, Schaeffler in Brașov, Preh in Iași, Honeywell in Bucharest, etc., which absorbed many highly trained Romanian engineers.

6 Higher Education in Machine Building

Before 1948, design and execution engineers working in the field of machine building were trained either at the general (electromechanical) profile departments of technical universities in Romania (Bucharest, Timișoara, Iași) or at technical universities abroad. It was *only after 1948 that the faculties of mechanics with specialised machine and machine tools building technology departments (TCM) were created after the Soviet model (BAUMAN). The first machine tools departments were founded by the decree of the Minister of Public Education in 1948 at the Technical Institute of Bucharest, the Technical University of Iași, and the Mechanical Institute of Cluj. As a result of this decree, departments of Machine Tools and later of Machine Tools and Instruments were founded in all three universities. These departments were headed by Professor Emil Botez in Bucharest, Professor Gheorghe Cașler in Iași, and Professor Wilhelm Rohonyi in Cluj. Professor Emil Botez is considered the founder of the Romanian School of Machine Tools. In 1949, the Machine Tools and Devices Department was founded at the Mechanical Institute of Brașov, headed by Professor Silviu Crișan. This department was the predecessor of the Department of Machine Building Technology. In 1954, the Department of Metal Processing Technology and Machine Building was founded at the Mechanical Faculty of the Technical Institute of Bucharest. Professor Constantin Popovici was appointed as Head of Department. At the Technical Institute of Brașov (which changed into the University of Brașov in 1971), the first Department of Metal Processing Technology and Machine Building was founded in 1954, by the transformation of the Department of Machine Tools and Devices. This department was headed from its foundation by Professor Silviu Crișan until his death in 1965. The Department of Machine Building Technology at the Technical University of Cluj was founded in 1955, headed by Professor Ion Lăzărescu. The first Department of Machine Building Technology at the Technical University of Timișoara was founded in 1960, headed by Professor Gheorghe Savii. The machine building technology specialisation (TCM) of the Technical Institute of Iași existed since 1954, but the Department of Machine Building Technology and Agricultural Mechanics was founded only 10 years later, in 1964, with Professor Constantin Picoș as the first Head of Department. At the Technical Institute of Galați, today the University of Galați, the courses in the Technology of Machine Building were introduced in 1963. The first Head of Department was Professor Mircea Manolache. The first Departments of Machine and Machine Tools Building Technology were founded at the most important industrial centres in the country (Bucharest, Cluj, Iași, Brașov, Timișoara, Iași, Galați) and were coordinated by experts trained at prestigious technical universities from Germany, Sweden, USSR, and experienced in production as well. The fast growth of production capacities in machine building posed a complex problem regarding the training and expertise of the production staff. Therefore, in addition to the main technical institutes of Bucharest, Cluj, Timișoara, and Iași, because of the demand on the labour market, new departments of engineering were founded and developed at certain Higher Education Institutes or Colleges. Machine*

Building Technology Departments and specialisations were created in several industrial centres where such kind of institutes existed already or were created at that time: *The University of Pitești (1972), the University of Sibiu (1976), the University of Bacău (1976), the Ștefan cel Mare University of Suceava (1976), the University of Craiova (1977), the University of Târgu Mureș (1977)*. After 1990, Departments of Machine Building Technology were created at the universities of Oradea (1990), Târgu Jiu (1991) and Arad (1999).

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