

## **NARROW GAUGE STEAM LOCOMOTIVES AND THEIR BUILDERS IN HUNGARY**

UDC 629.422

### **Summary**

Narrow gauge railways played an important role in the development of countries during the industrialisation process at the end of 1860s and at the beginning of 1870s. Countries like Japan and Switzerland, which are among the leaders in the field of modern industrial technology today, together with Hungary, achieved the fastest dynamic industrial development before the World War I. The 20 000 km long national railway network in Japan is of 1056 mm gauge. Switzerland also had a large narrow gauge (1000 mm) network. In 1918, Hungary had a 6700 km long narrow gauge network together with an 18 000 km standard gauge network. In the Austro-Hungarian Empire, the 760 mm gauge network in Bosnia and Herzegovina was 1700 km long. After the World War II, one third of the Hungarian railway network was still narrow gauge. The operation of narrow gauge network created special requirements and tasks for the Hungarian steam engine builders.

*Key words:*        *steam locomotive, railway history, narrow gauge railways*

### **1. Introduction**

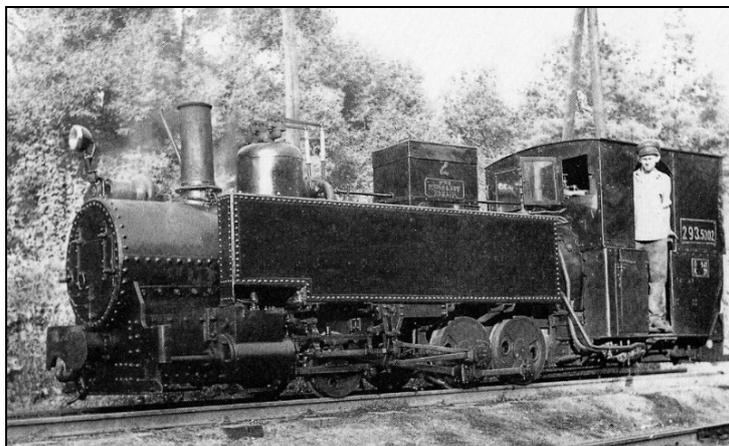
At the beginning of the 1950s, powerful meter gauge steam engines were put into service in Hungary. The locomotives were built in Budapest for the large Yugoslav 760 mm gauge network, but they remained in Hungary because of political reasons and were converted to meter gauge engines. The locomotives belonged to a large family of JŽ (Jugoslavenske željeznice - Yugoslav Railways) 83 class steam engines comprising more than 180 locomotives built in Austrian, German, Hungarian and Yugoslav locomotive factories between 1903 and 1949. It was a narrow gauge locomotive type, built predominantly in Austria. At the time when they were first built in the Krauss Locomotive factory in Linz, they were the most powerful 760 mm gauge locomotives of the Austro-Hungarian Empire and the Continent. They were also the largest narrow gauge locomotive class of JŽ and the most powerful narrow gauge steam engines to be put into service in Hungary. These are the most important features of the type, which history has connected with several countries of the region, including Croatia, because of the Dalmatian coast where the lines of the large 760 mm

gauge network reached the Adriatic Sea. Another important fact connects this locomotive class with the Hungarian steam engine builders: half of the locomotives of the compound version of the JŽ 83 class were built in Budapest. Six different types of steam engines were built in the Hungarian Locomotive factories for the large Bosnian and Yugoslav 760 mm network between 1899 and 1949, most of them were designed in Austria, in Linz. But after the World War I, the JŽ 85 class was a Hungarian design.

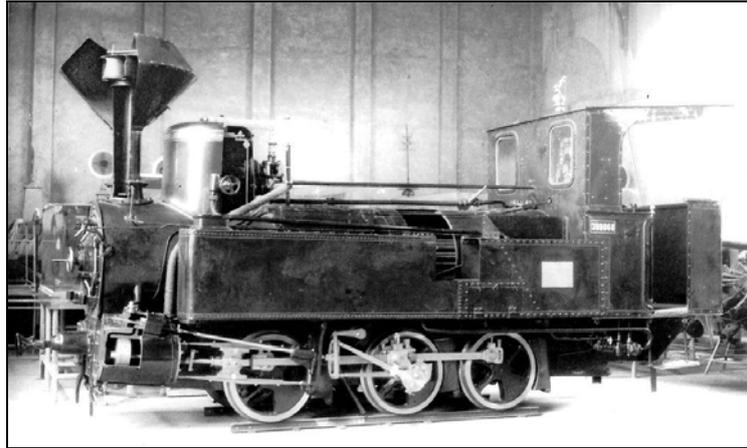
## 2. The first narrow gauge lines and narrow gauge steam locomotives in Hungary

Although the first steam operated Pest—Vác railway was opened in 1846, the industrial development could be started in the old Kingdom of Hungary only after the agreement of 1867, which regulated relations between Austria and Hungary after the difficulties caused by the revolution and the liberation war of 1848-49. More and more new factories were built after 1867, using steam operated machinery in their production processes. The development and enlargement of the national railway network were started by the establishment of the Magyar Királyi Államvasutak (Royal Hungarian State Railways – MÁV). The new Iron Works of Diósgyőr, replacing the old steel mills, began to produce the railway raw materials in 1869. The MÁV Machine Factory started the production of railway equipment and the maintenance of rolling stock in 1870. Also, private companies, like the iron factories and steel works of Rimamurány-Salgótarjáni Vasmű Rt. (Rimamurány-Salgótarján Ironwork Co. - RMST), and of the Állami Vaspályatársaság (State Railway Company - ÁVT - Staats Eisenbahngesellschaft – StEg in German) in Resicza, were the most important pillars of the railway industry in Hungary at that time.

Increasing industrial production required more and more coal for feeding the steel furnaces and the boilers of steam-operated machinery in the newly-built factories. New coal mines were opened after 1867, where the coal was transported on narrow gauge railways operated by horse-drawn trains. The power of the horses was not sufficient for to fulfilling the increasing transportation demands; therefore, new steam engines were put into service and in a short time replaced the horse-drawn trains on the busy colliery lines. The first narrow gauge steam engines were put into service in Hungary in 1870, a few years after that steam traction was introduced on the Ffestiniog Railway in Wales. These Hungarian engines were built by German locomotive manufacturers. (Fig. 1) (Fig. 2)

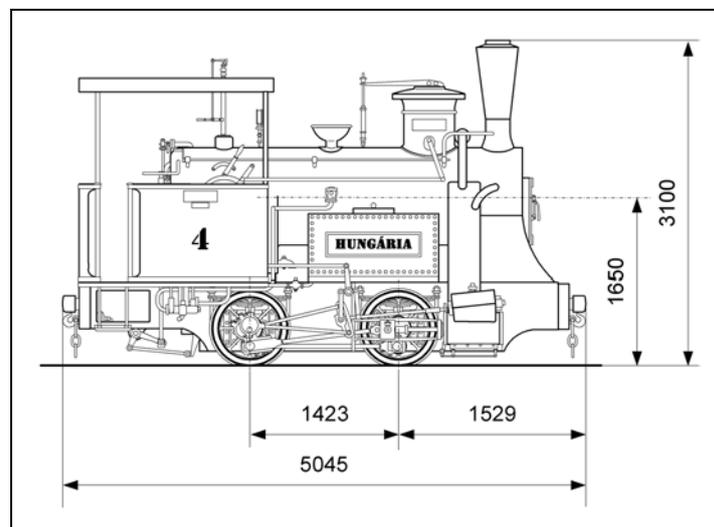


**Fig. 1** Locomotive of meter gauge Diósgyőr—Percsi Colliery Railway, built by Wöhlert Berlin, arrived in Miskolc in December of 1870. (Photo: László Mohay)



**Fig. 2** 790 mm gauge locomotive of Salgótarján Steel Works built by Krauss Munich in 1870 (Transport Museum of Budapest)

John Haswell's "*Szekul*", manufactured in Vienna by the Locomotive Factory of the Vienna—Győr Railway Company, was put into operation on the 950 mm gauge industrial network of the Resicza Iron Factory in 1871, and three steam engines, identical with "*Szekul*", were built in Resicza. The first locomotive manufactured in the countries of the Hungarian Holy Crown was ready to run on the 950 mm industrial network of the Resicza Iron Factory in 1872, preceding the first standard gauge locomotive built in Budapest by a few months. The last of the three locomotives, which had running number 4 and the name "*Hungária*", was introduced in the following year at the Vienna World Exhibition, and at the Millennium world exhibition in Budapest in 1896, as the first steam engine ever built in Hungary with Hungarian raw materials. [1] [2] (Fig. 3)



**Fig. 3** Locomotive "*Hungária*" built in Resicza in 1873.

Two new narrow gauge locomotives were put into service on the 790 mm gauge network of Salgótarjáni Kőszénbánya Rt., (Salgótarján Coal Mine Company) in 1876. The locomotives were built in Budapest by MÁV Machine Factory as the first steam engines designed by Hungarian locomotive manufacturers. (Fig. 4)

Although the first meter gauge public railway in Hungary was put into service between Garamberzence—Selmecbánya in 1873, the narrow gauge lines remained the efficient devices only for short distance industrial transportation. Although the number of the same type

standard gauge locomotives produced in MÁV Machine Factory reached several hundred units by the end of the century, the production of the narrow gauge locomotives was characterised by a few steam engine only in small batches. Sixty different steam locomotive types were built in Budapest between 1873 and 1900. A quarter of them were narrow gauge, but the number of the narrow gauge locomotives was a little more than 25 among the 1500 produced. [3]

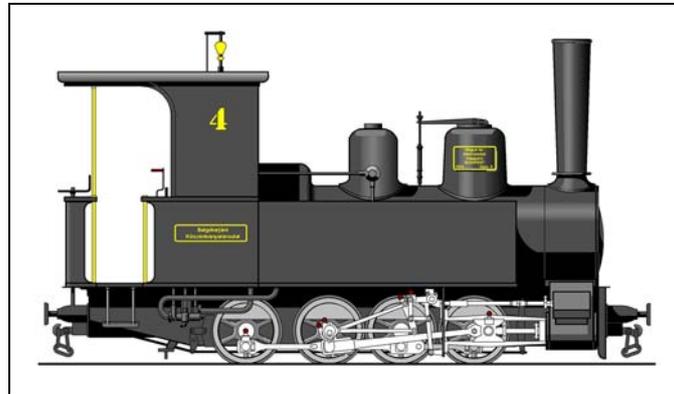


Fig. 4 790 mm gauge locomotive of Salgotarján Coal Mining Company, built in Budapest in 1876

### 3. Construction of local railway networks

The Hungarian Parliament forced and helped the construction of the secondary, local railway network with the aim of increasing the traffic on the main lines, extending the positive influence of the railways to the underdeveloped rural areas and connecting them to the economic life and creating markets for the new products of the Hungarian railway industry. More than 7000 km of local line network was built in Hungary between 1880 and 1900 based on Considere's theory stating the following: "*The railway lines do not make any economic influence on the markets which are farther than 12 km from the axes of the tracks*".[4] According to the Local railway Acts 1880. XXXI. and 1888. IV., the builders of the secondary lines were private companies. By the so-called Standard Contracts, they were obliged to use the products of Hungarian industry and apply the regulations of MÁV, or one of other big private railway companies like Déli Vasút (Southern Railway – DV – Südbahn in German) and Kassa Oderbergi Vasút (Kassa Oderberg Railway - KsOd), whose network their local lines were connected to and were operated by them. The Hungarian State guaranteed and paid the interest for Local Railway Private Companies even if the operation of the lines was not profitable. The result was a fast growing secondary network. The length of standard gauge local lines put into service in the year of 1896 was more than 900 km.

### 4. The golden era of narrow gauge locomotive builders

The Hungarian Parliament supported local companies and enterprises which produced the same quality products at lower costs or at least at the same costs as foreign companies.[5] A lot of private enterprises started the production of railway equipment and rolling stock. Also, Weitzer János Gépgyár és Vasöntöde, (Weitzer János Machine Factory and Foundry) in Arad started the production of steam locomotives in 1896. One hundred and thirty two steam engines were built there in the next nine years, including 65 for the narrow gauge. The most popular and well known locomotives of the Arad Factory were the MÁV class XII (later series 377, MÁV Machine factory type 29) and the Austrian design IIIa3 class, 760 mm gauge, Klose system locomotives of Bosznia-Hercegovinai Országos Vasutak (Bosnia-Herzegovinian National Railways – BHOV). (Fig. 5)

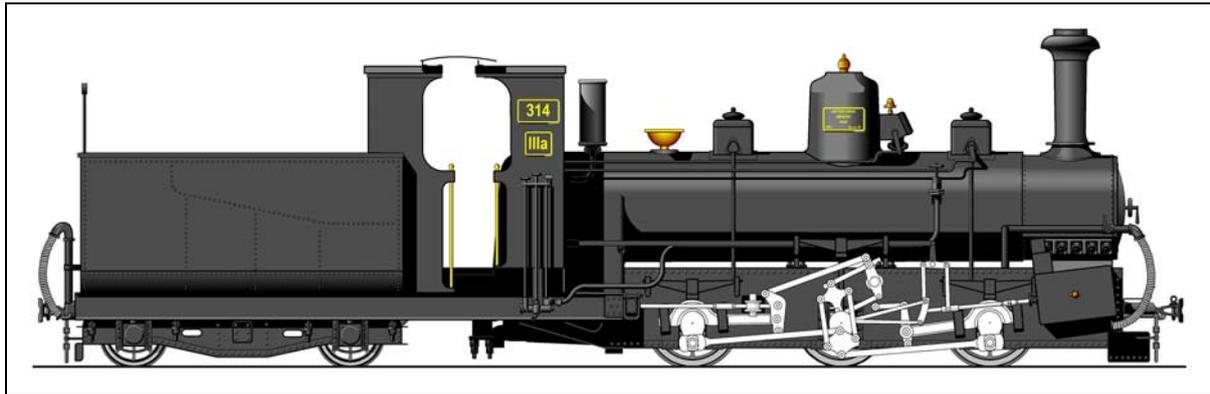


Fig. 5 BHOV class IIIa3 locomotive built in Arad

Besides the big producers, railway workshops also started to build locomotives. The first new steam engine in the railway workshop of Rimamurány-Salgótarjáni Vasmű Rt. (Rimamurány-Salgótarján Ironwork Co. - RMST) Ózd factory was built for its own 1000 mm gauge industrial network in 1898.

The fast growing secondary network generated an economic crisis by the end of the century. The Hungarian State abandoned the making of new Standard Contracts. Because of the lack of finance more and more local railway lines, which had been planned earlier as a part of the standard gauge network, were constructed in narrow gauge from the second half of the 1890s. The Royal Hungarian State Railways (MÁV) also forced the construction of new narrow gauge forest railways by excluding the transport by rivers of timber bought for producing wooden sleepers.

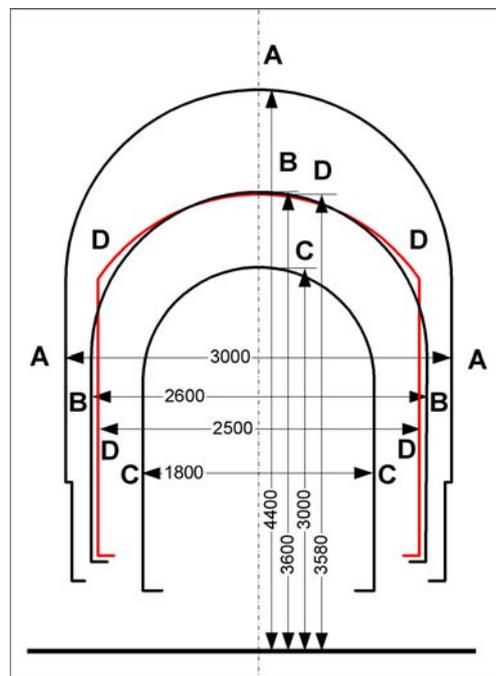
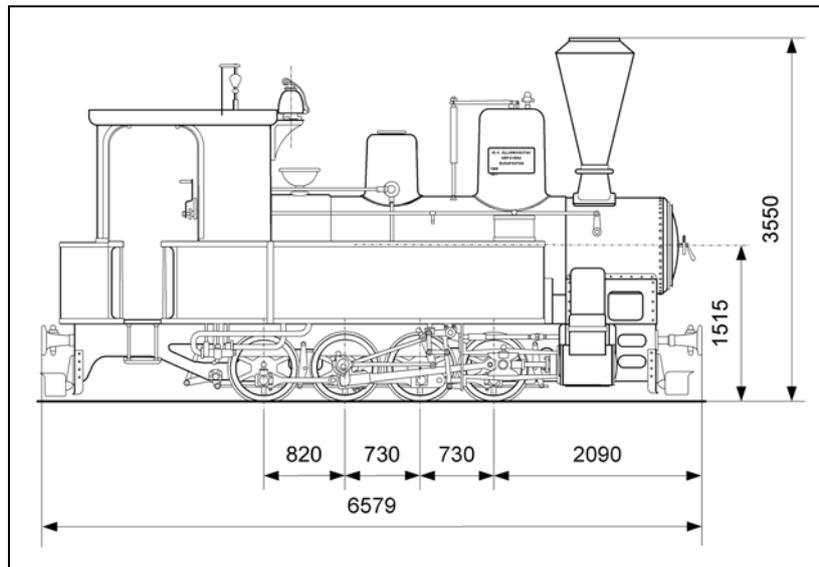


Fig. 6 Loading gauge of different gauge railways and Bosnia Railways in 1880s. A- 1435 mm gauge railways, B – 1000 mm gauge railways, C – 750-760 mm gauge railways, D – Boszna Railway

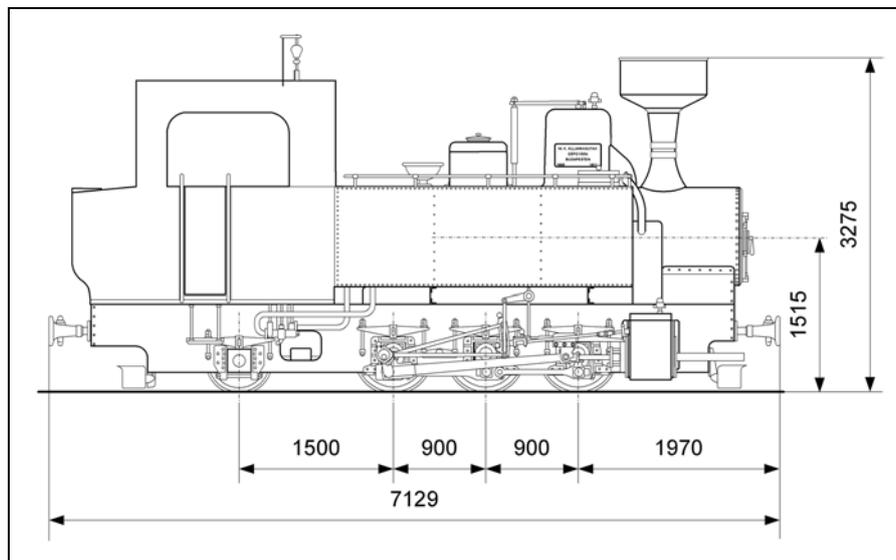
The adoption of the meter gauge loading gauge by the 760 mm gauge Bosnia Railway in the 1880s opened a new era in the construction of narrow gauge steam engines. (Fig. 6) The success of the 760 mm gauge Bosnia Railway provided evidence that narrow gauge lines can fulfil economically the transportation demands of areas with low population density and rural areas. The steam engines built for the narrow gauge industrial railways were characterised by

high tractive effort and relatively low speed, the ability to negotiate the small curve radii, climb steep gradients, and fit the small loading gauge of the cross section of the narrow and low tunnels in the mines and gates in the workshop areas.[6] The loading gauge of the narrow gauge track local railways was larger due to the demands of public service. As the narrow gauge local railways played an increasingly important role in the national rail traffic network, their lines became longer and their networks larger. By the end of the century the operation of 60-80 km long narrow gauge local lines demanded a faster train service than on the short line sections built before the 1890s. Because of longer distances, it was necessary to increase the speed of trains up to 30-35 km/h. Also, the narrow gauge industrial railways opened their lines for public service at the end of the century.



**Fig. 7** Type 47 locomotive “Hégen” of Segesvár—Szentgotthai Local Railway, the first 760 mm gauge locomotive built in Budapest.

The narrow gauge local railways became very popular by the end of the century as even though they had lower investment and operational costs they provided the same quality of service as the standard gauge secondary lines. The MÁV Machine Factory started to develop its own narrow gauge local railway locomotive types.

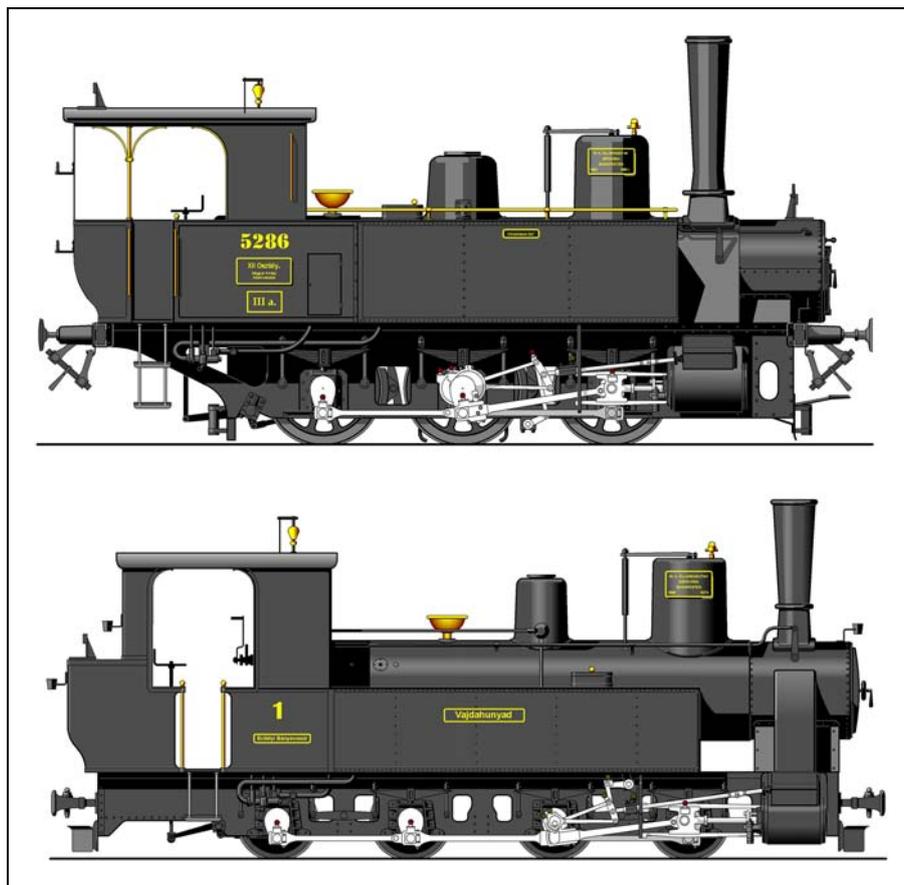


**Fig. 8** The local railway locomotive of 760 mm gauge Szatmár—Erdődi Local Railway built in Budapest and designed in Austria as type 48. One locomotive was also built in Arad.

In 1899, three different 760 mm gauge tank locomotives were built in the MÁV Machine Factory. The eight-wheeled type 47, called “*Hégen*”, built for the Segesvár—Szentágotai HÉV (Segesvár—Szentágotai Local Railway), was constructed on the basis of long experience in building industrial locomotives. It had a short wheel base and high tractive effort. (Fig. 7) The type 48 designed in Austria and built for the Szatmár—Erdődi Local Railway was a typical local railway locomotive. It had a 0-6-2 wheel arrangement and could run at 30 km/h top speed in passenger service, meeting the traffic demands of the narrow gauge local networks in the Austro-Hungarian Empire at the end of the century. (Fig. 8)

The eight-wheeled type 51 combined the features of the industrial and local railway locomotives, and could run in public service and also on the steep gradients and sharp curves of industrial sidings.

Its construction was based on the design of the type 29 standard gauge local railway locomotives, with the idea that if a narrow gauge local railway wanted to provide the same level of service as a standard gauge line, then it was necessary to use as powerful locomotives as the standard gauge ones. So narrow gauge local railway locomotives were smaller gauge sisters of standard gauge ones of the time [7] (Fig. 9). Comparing the features of the two types, the boiler capacity of the type 29 locomotives was higher because of its larger grate area and heating surface, but the type 51 had a higher tractive effort. It had Klien-Lindner hollow axles to negotiate the small curve radii. Unfortunately, despite the good features its 24 t service weight was too heavy for the 760 mm gauge local network built for axle loads of less than 5.5 tonnes.

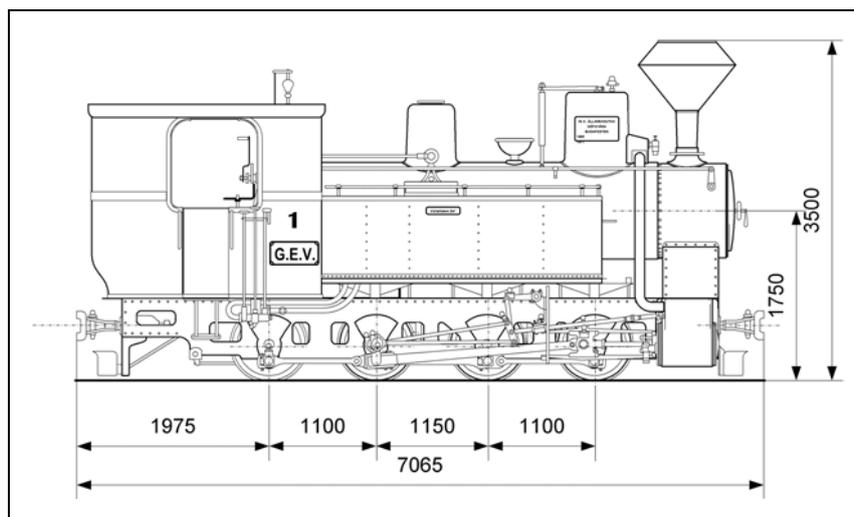


**Fig. 9** Above: Standard gauge MÁV class XII locomotive. More than 500 units were built in different Hungarian and Austrian locomotive factories between 1885 and 1924. Below: the smaller sister, type 51 narrow gauge local railway locomotive equipped with Klien-Lindner axles.

## 5. Standard type of narrow gauge locomotives

After a long period of experiments and drafting of several narrow gauge locomotives, the first steam engines meeting the traffic demands of the 760 mm gauge networks in Hungary at the beginning of the 20<sup>th</sup> century were put into service in 1905. This was type 70, which could run at 30-35 km/h on local railway lines and on 60 ‰ steep gradients and also negotiate 30 m radius curves on industrial sidings. It could also be fired by wood or coal at the request of the operator.

The main frames of the locomotive were made from 17 mm thick steel plate. The cylinders, having Stephenson valve gear, were outside the framing. The diameter of the wheels was 750 mm. The first and fourth wheel-sets were equipped with Klien-Lindner hollow axles. With the rigid wheel base of 1150 mm, the locomotives could run on 30 m radius track curves. The riveted boiler made from 12 mm thick steel plates had 14 bar steam pressure. The fire box made from copper plates had a 1.04 m<sup>2</sup> grate area. Inside the 916 mm diameter boiler, there were 128 40 mm diameter smoke tubes and their length was 2700 mm. The heating surface of the boiler was 48.14 m<sup>2</sup>. The locomotives, because of wood firing, were delivered with Klein type chimneys equipped with turbine spark-catcher. There was a large 3 m<sup>3</sup> area in the driver's cab for the storage of wood. The power of the locomotives reached 120 HP (88.3 kW) in the case of wood firing. The first three of type 70<sup>1</sup> locomotives with the production numbers of 1810-12 were put into service in Szászrégen on 31<sup>st</sup> of August 1905. (Fig. 10)



**Fig. 10** The type 70 narrow gauge locomotive of Görgény Valley Forest Railway

The construction works began on the 51 km long Szatmár—Bikszádi HÉV (Szatmár—Bikszádi Local Railway) 760 gauge local railway line in March of 1905. The new line had a connection at Szatmárnémeti Kossuth kert station to the Szatmár—Erdődi and Nagykároly—Somkúti HÉV (Szatmár—Erdődi and Nagykároly—Somkúti Local Railway) lines operated by MÁV, making a big 760 mm network in that region. The first 35 km section between Avasújváros and Szatmárnémeti of the new line ran across the plains. The rest of the line from Avasújváros to the famous salt bath of Bikszád climbed up on a gradient of 18 ‰ with 80 m curve radius through the Valley of Avas Mountains. The contractor was required to buy the material and the rolling stock from Hungarian factories. The MÁV Machine Factory built two coal-fired type 70 locomotives for this order.

The driver's cab of the coal fired type 70<sup>3</sup> locomotives was modified to carry 800 kg of coal. The balance-weights integrated with the outside cranks were put on the wheels. Better balancing of the driving-gear made the increase in speed to 30 km/h possible. The

locomotives were equipped with a train steam heating device according to the demands of the local railways. The power of the locomotives reached 150 HP (110 kW) in the case of firing with MÁV Standard coal. The first two type 70<sup>3</sup> locomotives, classified XX1c. 6967-6968 steam engines were put into service on the railway in the spring of 1906. In 1908, additional four type 70<sup>4</sup> locomotives were delivered to the Szatmár—Bikszádi Local Railway.

Soon, the delivery of the first locomotives was followed by a large number of orders. The type 70 locomotives became a basic steam engine type in a short time on the 760 mm gauge 5.5 t axle load lines built in the Carpathian basin before 1920. Their good features, the ability to negotiate sharp curves, the large boiler capacity and the ability to take overweight loads made them economically viable on both the local and industrial networks of forest and mining railways, compared to the Austrian and German locomotives built for similar duties and running on the Hungarian narrow gauge lines.

Before the end of the First World War, 31 units were put into service on the narrow gauge Szatmár—Bikszádi, Torda—Topánfalva—Abrudbányai and Maros-Tordai Local Railways operated by MÁV. Further eight units were delivered and put into service on the occupied territories, at the request of the War Department. Nine units were delivered to the forest and industrial railway lines.

A new regulation was published for the construction of 760 mm gauge railways containing three categories defined by the axle load of the lines. The regulation helped the standardisation of narrow gauge locomotives. The economic operation of the narrow gauge railways needed standard types of locomotives, which could run without restrictions both on the local and industrial railway lines including the light railways built to transport agricultural products. The construction of standard types for different railway companies shortened the time of locomotive manufacturing and decreased the production and maintenance costs. The MÁV Machine Factory, like the other Continental locomotive producers, excluding locomotives of special requirements, started to build standard narrow gauge locomotives. In the period from 1905 until the end of the First World War, the first units of the well-known narrow gauge steam engines of the MÁV Machine Factory were constructed and built, like types 75, 78, 85, 86, 94, 106 and 107, and among them the most successful type 70 locomotives.

**Table 1** Standardised narrow gauge locomotive types of MÁV Machine Factory classified according to axle load and power output with the number of locomotives built in brackets.

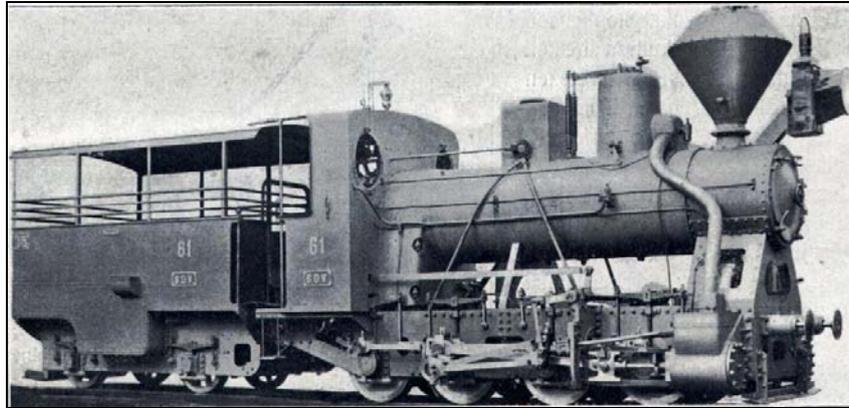
| Axle load     | Output, HP |            |  |            |            |            |             |
|---------------|------------|------------|--|------------|------------|------------|-------------|
|               | 30         | 40         | 50                                       | 60         | 80         | 90         | 150         |
| 3.7 t maximum | 99<br>(16) | 79<br>(10) | 75<br>(82)<br>106<br>(40)<br>107<br>(25) | 94<br>(29) | -          | -          | -           |
| 4.5 t maximum | -          | -          | -  | 86<br>(18) | -          | 85<br>(90) | -           |
| 6 t maximum   | -          | -          | -  | -          | 78<br>(20) | -          | 70<br>(142) |

**Table 2** Technical characteristics of standard type narrow gauge locomotives built by MÁV Machine Factory

| Power output, HP                    | 30         | 40                | 50                               | 50               | 50               | 60        | 60         | 80        | 90        | 150       |
|-------------------------------------|------------|-------------------|----------------------------------|------------------|------------------|-----------|------------|-----------|-----------|-----------|
| Type                                | 99         | 79                | 75                               | 106 <sup>2</sup> | 107 <sup>3</sup> | 94        | 86         | 78        | 85        | 70        |
| Built between                       | 1911-1941  | 1908-1925         | 1905-1913                        | 1916-1950        | 1916-1924        | 1910-1948 | 1909-1916  | 1908-1912 | 1908-1949 | 1905-1950 |
| Axle arrangement                    | C          | C                 | C                                | C                | C                | D         | C          | C         | D         | D         |
| Axle load, t                        | 2.67       | 3.1               | 3.7                              | 3.6              | 3.6              | 3.6       | 4.3        | 4.8       | 4.4       | 5.5       |
| Gauge, mm                           | 600<br>760 | 600<br>700<br>760 | 600<br>700<br>760<br>950<br>1000 | 760              | 760              | 760       | 600<br>760 | 760       | 760       | 760       |
| Cylinder diameter, mm               | 175        | 200               | 210                              | 220              | 220              | 250       | 250        | 280       | 280       | 325       |
| Piston stroke, mm                   | 260        | 280               | 300                              | 290              | 290              | 300       | 300        | 310       | 300       | 350       |
| Wheel diameter, mm                  | 600        | 580               | 600                              | 580              | 580              | 650       | 640        | 700       | 650       | 750       |
| Wheel base, mm                      | 1260       | 1300              | 1400                             | 1300             | 1300             | 2445      | 1500       | 1700      | 2750      |           |
| Boiler pressure, bar                | 12         | 12                | 12                               | 12               | 12               | 14        | 12         | 12        | 14        | 14        |
| Grate area, m <sup>2</sup>          | 0.338      | 0.44              | 0.51                             | 0.5              | 0.43             | 0.6       | 0.6        | 0.75      | 0.75      | 1.04      |
| Heating surface, m <sup>2</sup>     | 13.45      | 16.27             | 19.8                             | 23.7             | 18.8             | 25        | 24.5       | 30.7      | 30.7      | 48.14     |
| Service weight, t                   | 8          | 9.24              | 11                               | 10.2             | 10.2             | 14.15     | 12.9       | 14.5      | 17.5      | 22        |
| Tractive effort, kg                 | 1040       | 1390              | 1580                             | 1740             | 1740             | 2420      | 2080       | 2320      | 3040      | 3450      |
| Permitted speed, km/h               | 20         | 25                | 25                               | 25               | 25               | 20        | 30         | 30        | 30        | 35        |
| Negotiated smallest curve radius, m | 20         | 21                | 24                               | 21               | 21               | 20        | 28         | 36        | 25        | 30        |
| Highest track gradient, ‰           | 60         | 60                | 60                               | 100              | 100              | 60        | 60         | 60        | 60        | 60        |
| Water tank capacity, m <sup>3</sup> | 0.6        | 0.6               | 1.2                              | 0.84             | 0.84             | 1.2       | 1.3        | 1.4       | 2         | 2         |
| Coal storage, m <sup>3</sup>        | 0.35       | 0.4               | -                                | -                | 0.8              | 0.7       | 0.75       | 0.8       | 1.5       | 1.3       |
| Wood storage, m <sup>3</sup>        | 0.75       | 0.6               | 0.84                             | 1.9              | -                | 1.3       | 1.5        | 1.5       | 3         | 3         |

Studying the numbers of standard type locomotives it is evident that three categories were very popular: the locomotives of 50 HP for the lines of maximum 3.7 t axle load, 90 HP for the lines of maximum 4.5 t axle load, and 150 HP for the lines of maximum 6 t axle loads. The first category locomotives were built for agricultural and light industrial lines. The second were built for forest railways, industrial railways with or without passenger traffic, and also light local railways. The third were built for local railways and forest and industrial lines with heavier freight traffic with or without passenger service. Later, these figures were very important at the dieselization of railways.

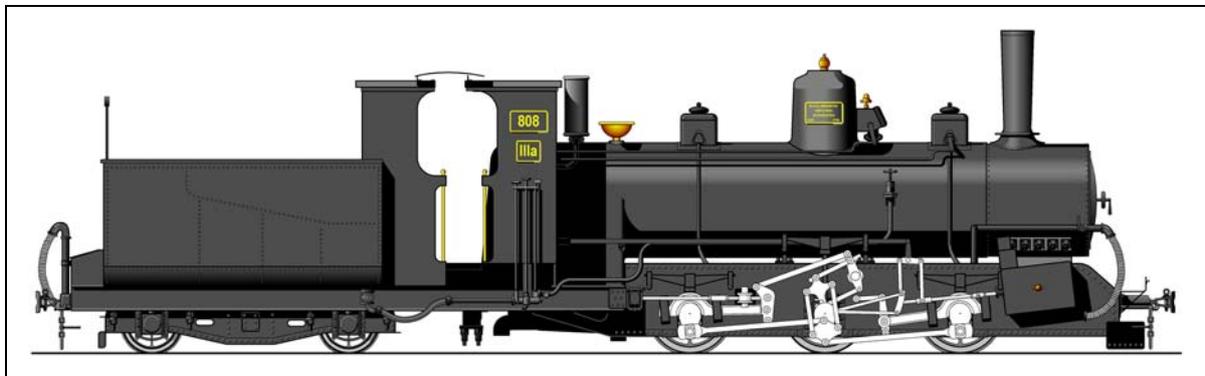
The MÁV Machine Factory also continued the delivery of locomotives for the special requirements of industrial railways, but nearly a half of narrow gauge steam engines produced was standard types. (Fig. 11)



**Fig. 11** One of the special locomotives was type 81s. Two units were built for the meter gauge Szlavóniai Drávavidéki HÉV (Slavonian Dráva Region Local Railway – SDV) in 1908.

## 6. Locomotives built in Budapest for the 760 mm gauge network in Bosnia and Herzegovina

After the forge-shop in Arad was burned down in 1904, steam engine production was stopped there and the MÁV Machine Factory took over the duties of the Arad factory and built the last four, heavier versions of the Hungarian class IIIa3 steam locomotives in Budapest for the 760 mm gauge Bosnian network.[8] (Fig. 12)

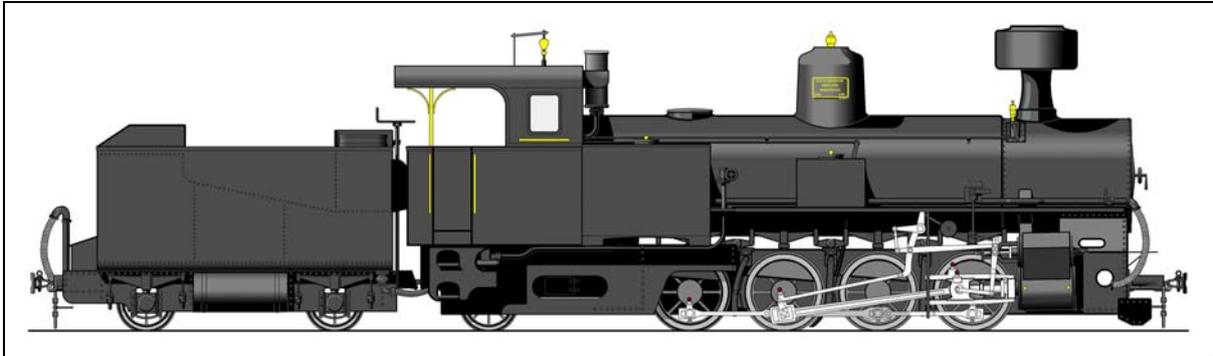


**Fig. 12** The heavier version of locomotive BHOV class IIIa3, built in Budapest MÁV Machine Factory as type 63 in 1904.

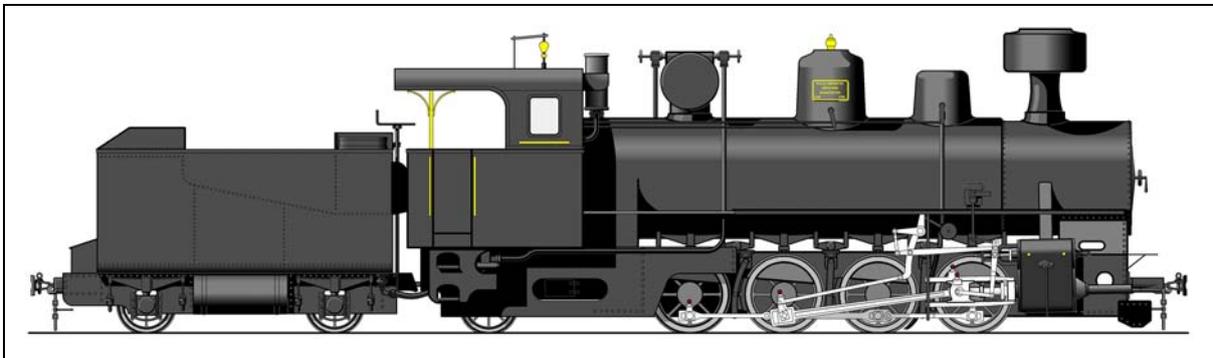
The more than 100 km long 760 mm gauge Bród—Sarajevo military railway built in 1878 became one of the most important railway main lines of the Austro-Hungarian Empire. It was planned to convert it to standard gauge but the introduction of the meter gauge railway loading gauge to the 760 mm gauge line made it unnecessary. The line became a backbone of a large network reaching the Adriatic coast by the end of the century. The traffic on the 760 mm gauge Bród—Sarajevo line was heavier than the standard gauge Galician main lines of the Monarchy. Express and night services were also introduced. The average speed of express trains running to Sarajevo was higher than on the standard gauge Wien—Trieste main line.

The very special narrow gauge products of MÁV Machine Factory were the Austrian designed type 82, 96 and 100 locomotives built for the BHOV. All of them were Austrian Krauss design, but the locomotives built in Budapest got more and more Hungarian characteristics, like Petz-Rejtő feed water cleaning equipment, as the number of produced

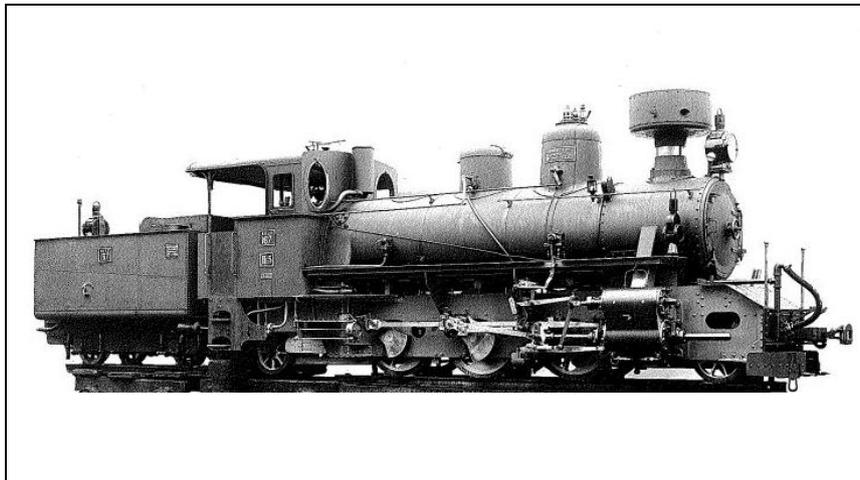
locomotives increased. Only five locomotives of type 82 and eight of type 100 were built in Budapest between 1908 and 1913, but the number of type 96 was 62 in six batches. (Fig. 13) (Fig. 14) (Fig. 15)



**Fig. 13** The first locomotives of the BHOV class IVa5 were two cylinder compounds, built in Budapest in 1908.



**Fig. 14** The superheated version of BHOV IVa5, built by MÁV Machine Factory and MÁVAG in Budapest as type 96<sup>1-6</sup>, between 1908 and 1948.



**Fig. 15** 760 mm gauge express train locomotive of BHOV IIIa5, also built by MÁV Machine Factory as type 100.

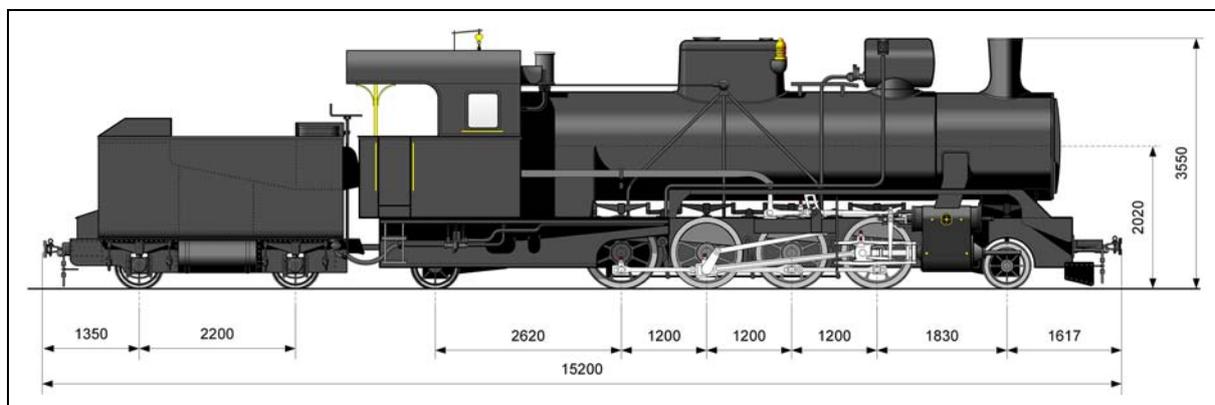
## 7. After the Word War I

After the end of World War I. Hungary lost two-thirds of its territory, but 80 % of rolling stock building capacity remained inside the new Trianon borders. The building of new steam locomotives was continued in Budapest. Some new designs of narrow gauge locomotives were developed in the MÁV Machine Factory, which got a new name in 1922,

i.e. Magyar Királyi Állami Vas- Acél- és Gépgyárak (Royal Hungarian State Iron, Steel and Machine Factories – MÁVAG). At that time, a six wheeled 750 mm gauge locomotive with super heater, type 127, and the type 128 narrow gauge locomotives were designed. 35 units of type 128, JŽ class 85 were built for the Yugoslav 760 mm gauge network in 1930-31. That type with its indicated power of 952 LE (700.7 kW) was the most powerful 760 mm gauge steam locomotive ever designed and built in Hungary. The basic principles of constructing the locomotives were the same as for the type 122, MÁV class 424 locomotives: economical operation and high steaming capacity of the boiler. Putting this locomotive in service shortened the travelling time between Belgrade and Sarajevo by five hours. (Fig. 16)

The Hungarian industry could produce great products also in small sizes at that time. The design and construction of type 128 locomotives in Budapest had the same importance in the history of Hungarian industry in that period as the type “Árpád” intercity railcars, which were competing with the Budapest—Vienna flights, the electric locomotives of Kandó Kálmán and the type 122, MÁV 424 class steam engines.

More than 21 percent of the steam engines built in Budapest between 1921 and 1938, were narrow gauge locomotives. Many of them, like the types 96 and 128, were delivered as war compensation to Yugoslavia. All the new narrow gauge locomotives, built in that period, except for one unit of type 127 and four new engines of type 70, were standard types with low power output, designed for light agricultural service or for hauling mine-wagons. Two newly-built type 70 locomotives were delivered to a logging company in Transylvania and two to the Gánt Aluminium Mining and Industry Company, where six small locomotives, among them two of type 70 and four of 85, carried 425 000 t bauxite in 1937 to Bodajk railway station 12 km away from the mine.



**Fig. 16** Locomotive type 128 of MÁVAG, designed and built for express train service between Belgrade and Sarajevo.

By the first Vienna Decision signed on 2<sup>nd</sup> November 1938, in the golden hall of the Belvedere palace, the southern part of the Hungarian Highlands was given back to Hungary. By this decision the Hungarian railway network was increased by 1164.5 km, including 121.8 km of narrow gauge lines. Further 328 km of standard gauge line and 99 km of narrow were reintegrated into the network of MÁV, after the occupation of the East part of Hungary on 15<sup>th</sup> of March 1939. A large network of forest and industrial railways was in operation on the reintegrated territories together with the narrow gauge local lines. As the result of the second Vienna Decision, the length of the Hungarian narrow gauge network was increased by more than 400 km with the reintegration of the North part of Transylvania.

The Hungarian State made strong efforts to improve the traffic conditions on the returned country lines. Investment into those territories during the Second World War was three times greater compared to the preceding 19 years. MÁV Headquarters decided to increase the

maximum speed up to 60 km/h on MÁV 760 mm gauge lines, to introduce the general adoption of the air brake both in passenger and freight service, and to increase the axle load up to 8-12 t. For the modernization of the rolling stock MÁV Headquarters ordered new steam engines, diesel railcars, passenger coaches and freight wagons of 15 t loading capacity from the Hungarian rolling stock factories. Putting into service the powerful 96 and 128 type locomotives on the Hungarian 760 mm gauge network was also taken into consideration. Some of the industrial railway locomotives, borrowed by MÁV, were used on the construction works of 760 mm gauge Szászlekenye—Koloznagyida line, which connected Marosvásárhely to Budapest before the new Déda—Szeretfalva standard gauge line was finished.

The MÁVAG Factory in Budapest received an order for the delivery of 30 new type 70 locomotives in 1940. The 35 year old locomotive type was modernized according to the new requirements of the 1940s. The locomotives got new cylinders equipped with Heusinger-Walshaert valve gear. The copper plates of the riveted fire box were replaced by steel plates. A MÁV system water cleaner was installed on the boiler. The regulator valve was moved into the dome and the main steam pipe was led through the tube plate via the smoke box to the cylinders. The exhaust pipes were outside. The cylinders and the exhaust pipes were insulated. The heating surface of the boiler remained the same, supplying saturated steam. The first two modernized type 70<sup>14</sup> locomotives were put into service on the forest railway of the Tarac valley in 1940. The locomotives had electric front lights and electric water gauge lighting in the cab.

In 1942, MÁV put into service 20 unit type 70<sup>15</sup> locomotives with the numbers 490,034-053. The locomotives were equipped with air brake and air compressor. Instead of the Klein type chimney, a mesh screen in the smoke box and simple tube chimney were installed on the locomotives. Because of the redesign of the boiler and the new valve gear, the speed of the locomotives could be increased to 35 km/h. The locomotives were put into service on the Marosvásárhely network, but they also ran on the Szatmár—Bikszádi and Szatmár—Erdődi Local Railways and also on the industrial railway of Gánt bauxite mines. By the end of the year, the class 70 became the Hungarian design narrow gauge steam engine type built predominantly, leaving behind the successful, but lighter, 75 and 85 types. (Fig. 17)



**Fig. 17** The restored MÁV 490,039, type 70<sup>15</sup> locomotive built for the Transylvanian network in 1942.

Further ten locomotives were ordered by MÁV in 1942, but the Soviet troops occupying Budapest confiscated the locomotives found in the MÁVAG workshops and on the basis of the agreement signed by the Soviet and the provisional Hungarian Government, they were converted to 750 mm gauge and put into service in the Soviet Union in 1945 and 1946.

## 8. Narrow gauge locomotive production in Hungary after the World War II

The transport demand of the reconstruction works in the post war period and the increasing industrial production capacity required new railway vehicles, among other things new powerful narrow gauge steam engines. The production of the type 70 locomotives was continued. In 1947 and 1948 twenty units of 70<sup>20</sup> type steam engines were built as Yugoslav war compensation. The 70<sup>21</sup> batches of the last 30 locomotives were built in 1949-50. Many modifications were introduced according to the demands of quantity production. The riveting was replaced by welding on the cab and on the water tank. The capacity of coal bunkers on the coal firing locomotives was increased to 1.3 m<sup>3</sup>. Three of them were delivered to Bulgaria, nine to Rumania, eight to Yugoslavia and ten remained in Hungary. MÁV put into service eight locomotives with the numbers 490,054-061 on its nationalised Sárospatak and Békéscsaba narrow gauge local network. Because the locomotives were built originally for export, they did not have air brakes and air compressors.

After the Second World War some other narrow gauge types were also built in Budapest. The last four of ten type 96<sup>6</sup> locomotives were not delivered to the customer, the state of Yugoslavia. Together with other two type 96<sup>5</sup> locomotives, they were converted to 1000 mm gauge and put into service in Hungary. They were the most powerful narrow gauge locomotives put into service in Hungary. (Fig. 18)



**Fig. 18** Locomotive No. 36 of Ózd Iron Works meter gauge industrial railway, MÁVAG type 966  
(Photo: Sándor Malatinszky)



**Fig. 19** Locomotive class K<sup>V</sup>4, No. 447,401 of Lillafüredi Állami Erdei Vasutak  
(Lillafüred Forrest Railways – LÁEV), in steam. (Photo: Ádám Jakóts)

The MÁVAG offered type 96 and 128 narrow gauge steam engines for the Soviet war compensation, but instead of the delivery of the factory own designs, the production of a new type, the Soviet K<sup>V</sup>4, was introduced in Budapest. 240 units of this type were built between 1950 and 1953. 234 were delivered to the Soviet Union and the rest remained in Hungary. (Fig. 19)

The last series of narrow gauge locomotives built in Budapest was a 1057 mm gauge 2-6-2 locomotive type of the Indian railways in 1957.

After the Second World War, the narrow gauge locomotive was one of the most important export products of the Hungarian heavy industry. Only 32, less than 10 % of the 380 narrow gauge locomotives built in Budapest, were ordered by Hungarian railway companies or originally built for export but put into service in Hungary.

## 9. Summary

The narrow gauge local and industrial railways formed the third and the fourth level of the national railway traffic systems at the beginning of the 20<sup>th</sup> century in central European countries, being efficient devices for short distance industrial transportation and useful facilities for local transport because of their low investment and operational costs. They were also an economic means of transportation in the lands and rural areas with low density of population. Their transportation capacity, including that of the horse-drawn wagons running on the light industrial railways, was variable, but the busiest lines reached and exceeded the transportation performance of standard gauge lines. The small loading gauge, the low axle load and the small track curve radii required careful designs for the rolling stock running on these indispensable lines, making special tasks for the steam engine designers and builders. The special requirements needed special solutions.

11 steam locomotive builders: machine factories, railway workshops, and workshops, more than 7760 steam engines, more than 1050 among them narrow gauge, characterize the history of Hungarian steam locomotive manufacturers. [9]

**Table 3** Steam locomotive builders in Hungary

| Steam locomotive builders and manufacturers |                                  | Number of locomotives built |          |       |             | Remarks               |
|---|----------------------------------|-----------------------------|----------|-------|-------------|-----------------------|
|   |                                  | Gauge                       |          |       | Sum         |                       |
|   |                                  | Narrow                      | Standard | Broad |             |                       |
| Machine factories                           | MÁV Gépgyár                      | 966                         | 5190     | 1412  | 7568        | 1873-1959             |
|   | Weitzer János Gépgyár, Arad      | 66                          | 65       | -     | 132         | 1896-1903             |
|   | Kachelmann Károly és Fia Gépgyár | 3                           | -        | -     | 3           | 1879-1883             |
| Railway workshops and factory workshops     | STEG (ÁVT Resica)                | 10                          | -        | -     | 10          | 1872-1905             |
|   | OMÁV Nyugati Műhelye, Budapest   | -                           | 1        | -     | 1           | in 1866               |
|   | MÁV Északi Főműhely              | -                           | 17       | -     | 17          | in 1908 and 1916-1918 |
|   | MÁV Istvántelki Főműhely         | -                           | 15       | -     | 15          | 1916-1918             |
|   | MÁK Tatabánya                    | 2                           | -        | -     | 2           | 1944-1946             |
|   | RMST Ózd                         | 6                           | 3        | -     | 9           | 1901-1957             |
|   | RMST, Salgótarján                | 4                           | -        | -     | 4           | 1899-1929             |
|   | Péti Nitrogénművek               | 1                           | -        | -     | 1           | in 1952               |
| <b>Sum:</b>                                 |                                  | 1058                        | 5291     | 1412  | <b>7761</b> |                       |

In 1958, the production of steam engines was stopped in Hungary. 7576 steam engines, 966 among them with narrow gauge, were built in Budapest between 1873 and 1958. Nearly a half of the 472 units were built of standard types, representing the heritage and history of the biggest Hungarian steam locomotive builder.

**Table 4** Locomotives built by MÁV Machine Factory and MÁVAG in Budapest

|                       | 1873-1905      | 1906-1920   | 1921-1938  | 1939-1944  | 1945-1958   | 1873-1958   |
|-----------------------|----------------|-------------|------------|------------|-------------|-------------|
| <b>Broad gauge</b>    | -              | -           | -          | -          | 1350        | <b>1350</b> |
| <b>Standard gauge</b> | 1783           | 2372        | 451        | 271        | 371         | <b>5248</b> |
| <b>Narrow gauge</b>   | <b>600 mm</b>  | -           | 28         | -          | -           | <b>28</b>   |
|                       | <b>633 mm</b>  | 10          | -          | -          | -           | <b>10</b>   |
|                       | <b>700 mm</b>  | 3           | 9          | -          | -           | <b>12</b>   |
|                       | <b>750 mm</b>  | -           | -          | -          | -           | <b>240</b>  |
|                       | <b>760 mm</b>  | 21          | 325        | 123        | 39          | <b>608</b>  |
|                       | <b>790 mm</b>  | 12          | -          | -          | -           | <b>12</b>   |
|                       | <b>1000 mm</b> | 4           | 12         | -          | -           | <b>56</b>   |
| <b>Sum:</b>           | <b>50</b>      | <b>374</b>  | <b>123</b> | <b>39</b>  | <b>380</b>  | <b>966</b>  |
| <b>Total sum:</b>     | <b>1833</b>    | <b>2746</b> | <b>574</b> | <b>310</b> | <b>2101</b> | <b>7564</b> |

Some of the locomotives are still running in passenger service with tourist trains. Taking into consideration their importance in the railway history, we are only successors and not the owners of this rich heritage.

There is only one steam engine of the BiH class 55 locomotives still running on the rest of the large Bosnian-Herzegovinian 760 mm gauge network. This particular locomotive built in MÁVAG in Budapest in 1947 sometimes transports tourist trains between Banovići and Zlaća near Tuzla.



**Fig. 20** The restored Locomotive No. 55-98 of Bosnia and Herzegovina in working order.

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