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Metro line No.1 in Budapest

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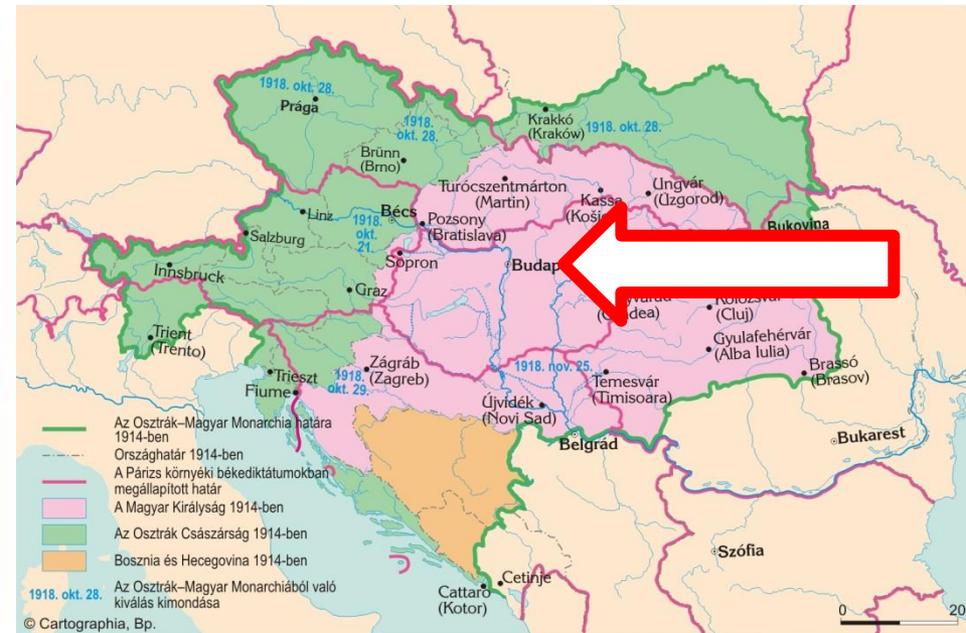
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Draft

1. Developing Budapest
2. Trams in Budapest
3. The project
4. The tunnel
5. Carriages
6. Stations
7. The track
8. Power supply
9. Renewals
10. Innovation

Budapest, Hungary in Central Europe



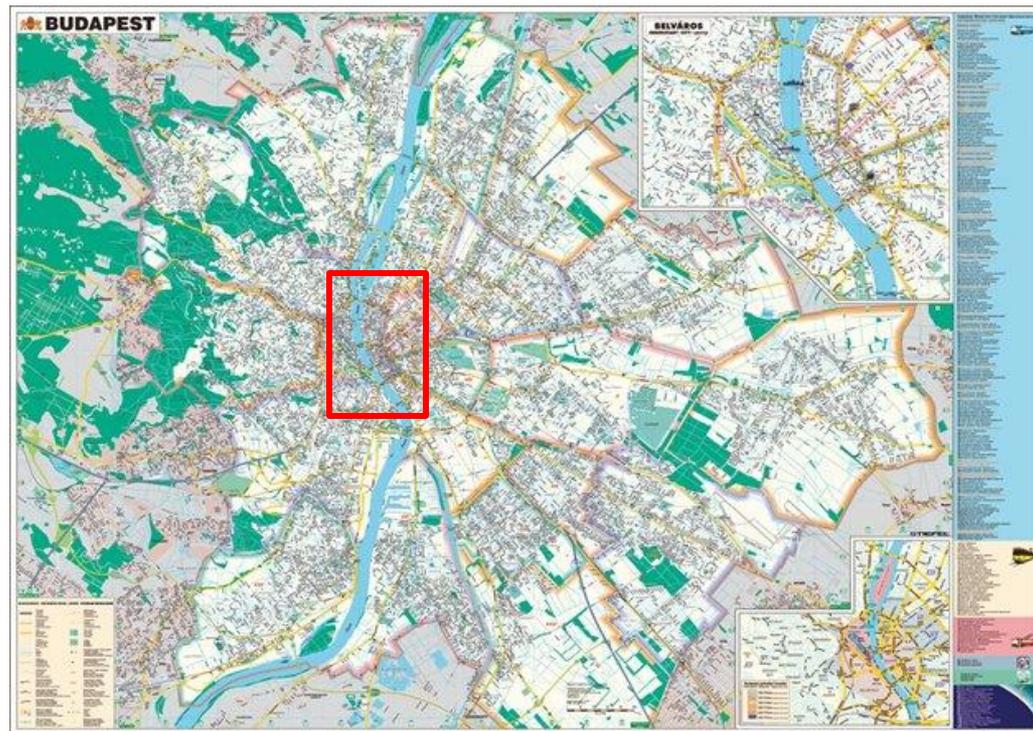
Developing city

- In 1873 three cities are unified:

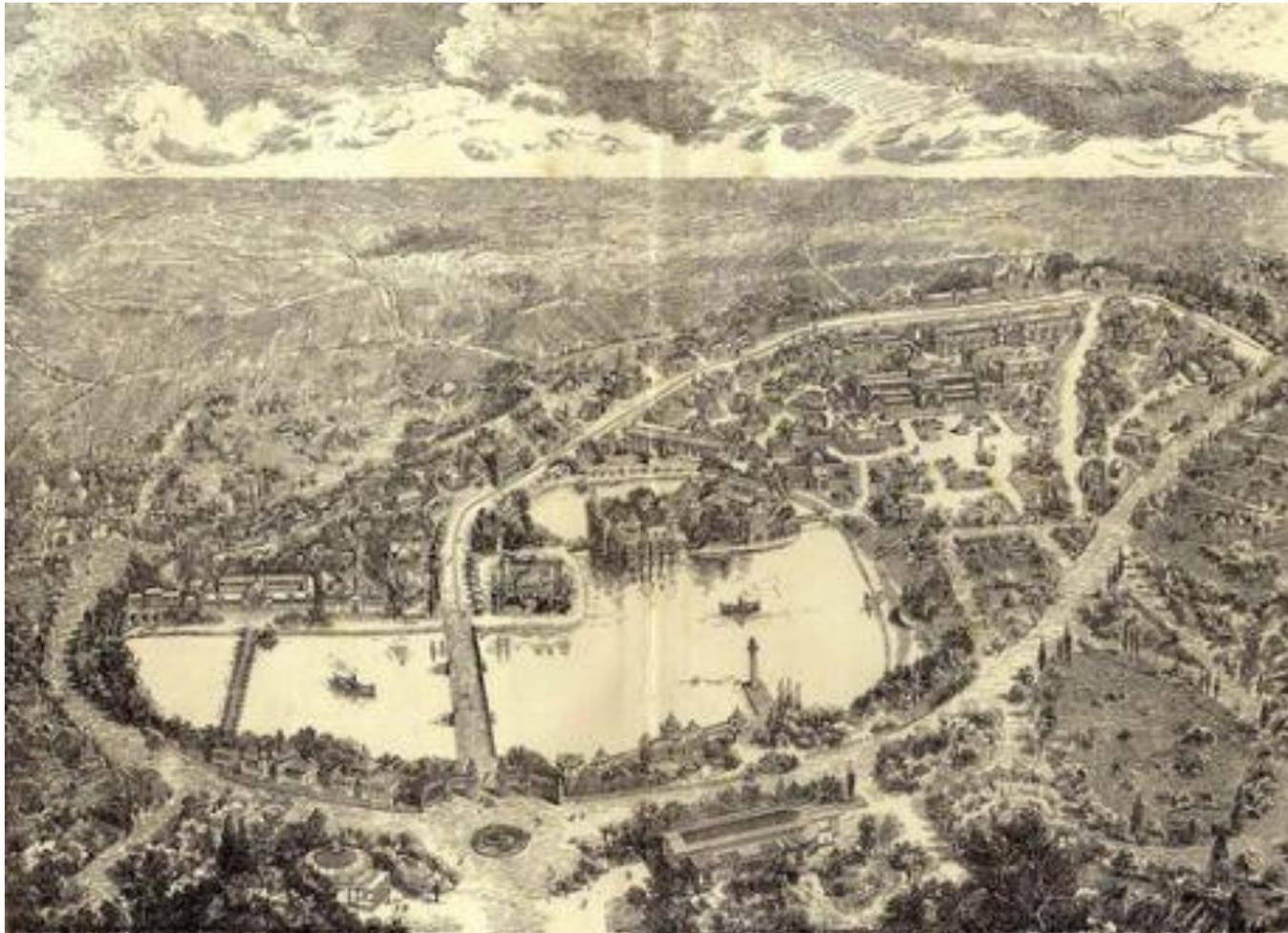
Pest + Buda + Óbuda = Budapest

- At the end of the XIXth century Budapest became a metropolis.
- In 1896 the country celebrated the thousand year anniversary of the statehood and the mayor's office wanted to raise the glare of the feast with an up-to-date technical solution.
- In 1873 more than 300.000 inhabitants lived in Budapest. This number was doubled in the next two decades.

1890 - 2010



World expo in 1896 for 1000 years anniversary

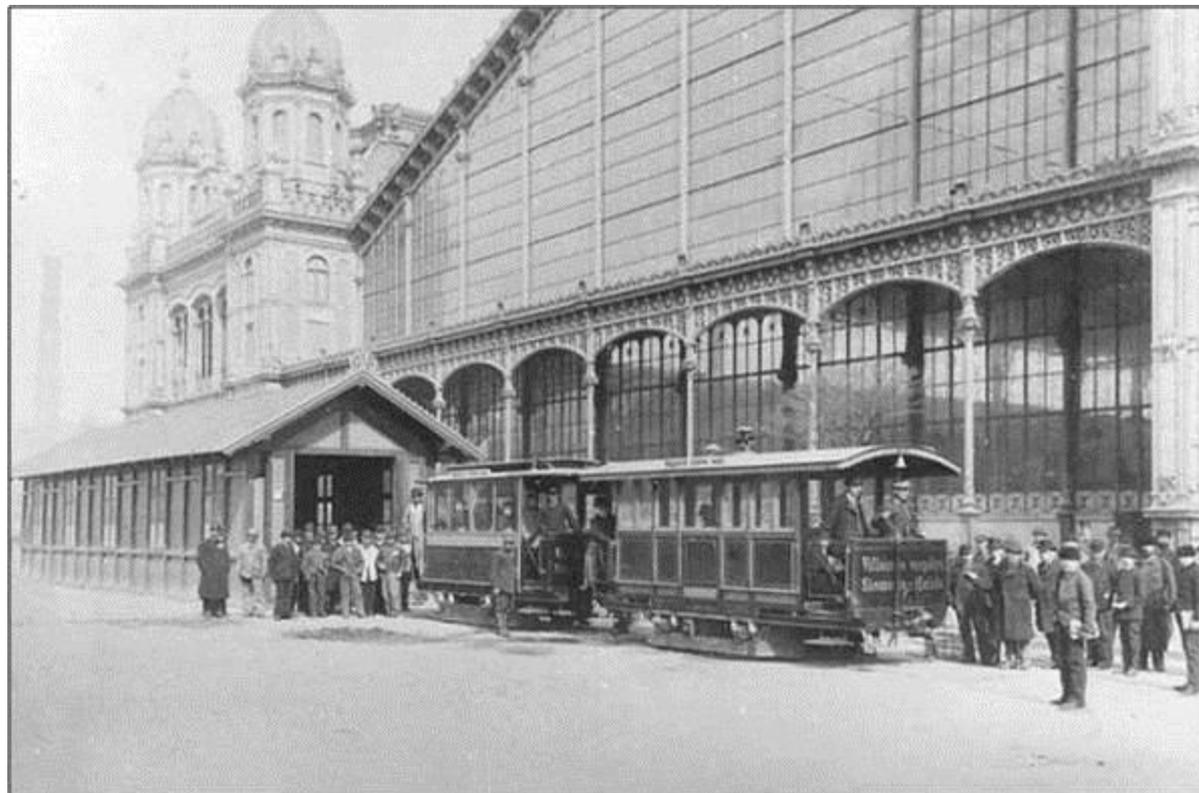


Trams in Budapest



- The monopolistic horse pulled tramway service company *Budapesti Közúti Vaspálya Társaság* (BKVT) had operated with 700 horses since 1860 but was not open for innovations.

Trams in Budapest



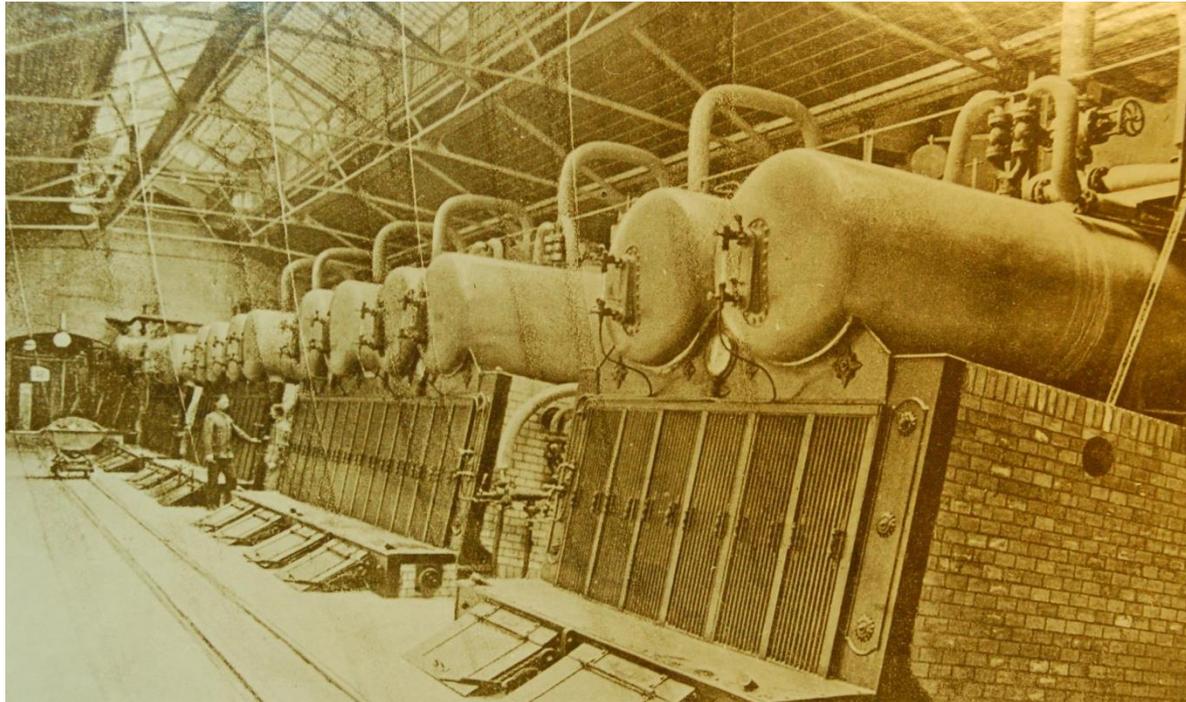
- In 1887 a 1000 m track was built by *Siemens & Halske* for electric tram with lower current collector (sunken below the surface).

Budapest system



- The collector was named “*Budapest system*” but its reliability was not too high because dirt could fall into the small ditch. Later this system was applied in Vienna and in Berlin, too.

Power for trams



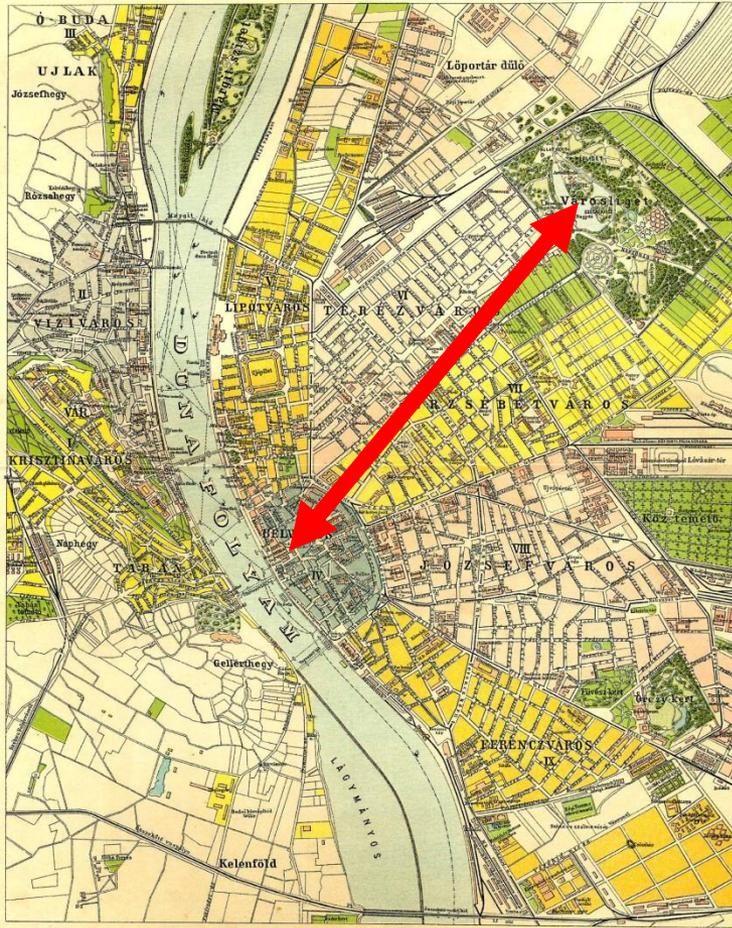
- For electricity supply a power plant was set up in “Akácfa street” by 3 pieces 100 HP steam turbine driven generators with 300 V DC.

The need

- In 1875 a new representative avenue was built between the center and the city park.
- For esthetic reasons no horse-pulled or electric tram line construction was allowed in this street.
- Closing the date of the celebration of 1000 years old Hungarian Kingdom (Millenia in 1896)



Connecting the center and the expo site



The solution

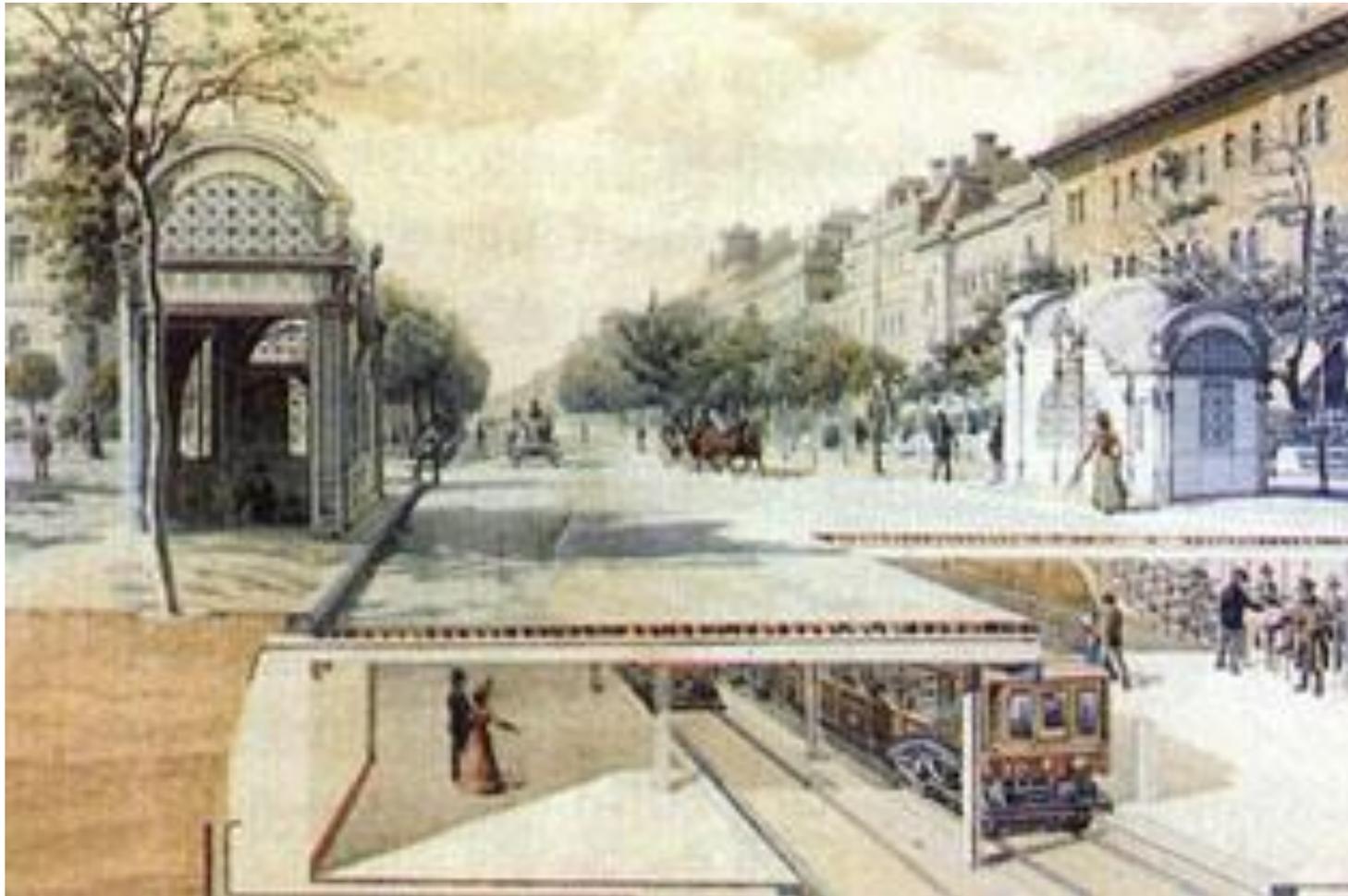
- In January of 1894 a tender was issued to solve the problem by an electric underground tram.
- This was a joint action by the two competitors: *Budapesti Villamos Városi Vasút (BVVV – Budapest City Electric Train Company)* and *Budapesti Közüti Vaspálya Társasággal (BKVT – Budapest Municipal Train Company)*.
- The decision was made on 9th of August, 1894.
- The tunnel and stations were built by entrepreneur *Robert Wünsch*, the bogie carriages were produced by *Schlick Vasöntöde és Gépgyár (Schlick Forgery and Machine Factory)*, and the electric devices were made by *Siemens und Halske Co.*

Balázs Mór – the project owner

Wünsch Róbert – the entrepreneur



Technical solution



On-the-time finished project

- The first electricity driven metro line in the continent was inaugurated on 2nd of May 1896 in the presence of Franz Joseph – Kaiser of the Austro-Hungarian Empire.
- On 8th of May Franz Joseph travelled on the whole line
- This royal course was driven by the great-great grandfather of the author.
- During the remaining 8 months of 1896 the metro carried 3 million passengers. This number rose to 11 million by 1917. The operating hours were between 6 AM and 11 PM with 4 min succession slots.

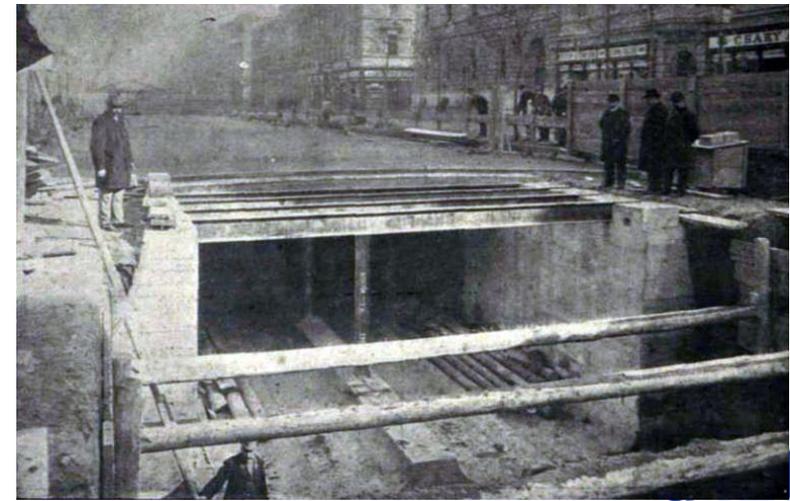
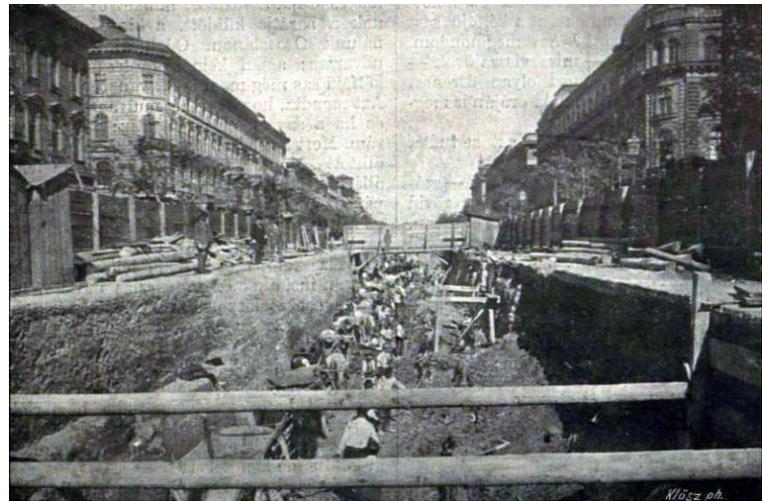
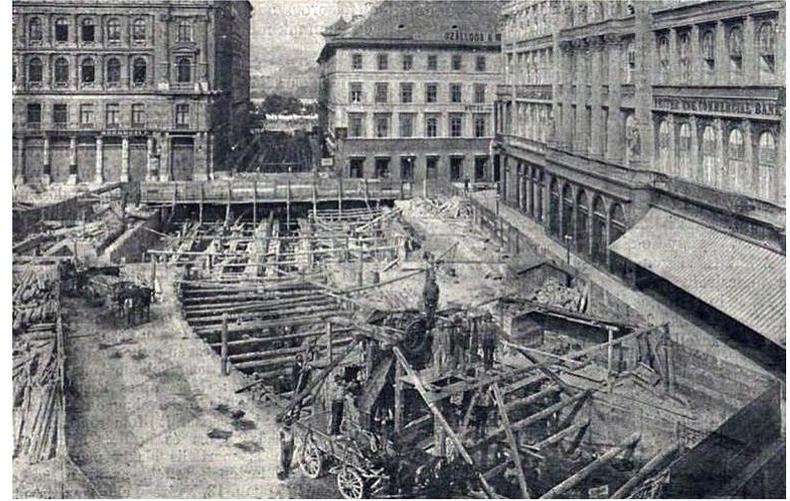
Ready for inauguration on 08/05/1896



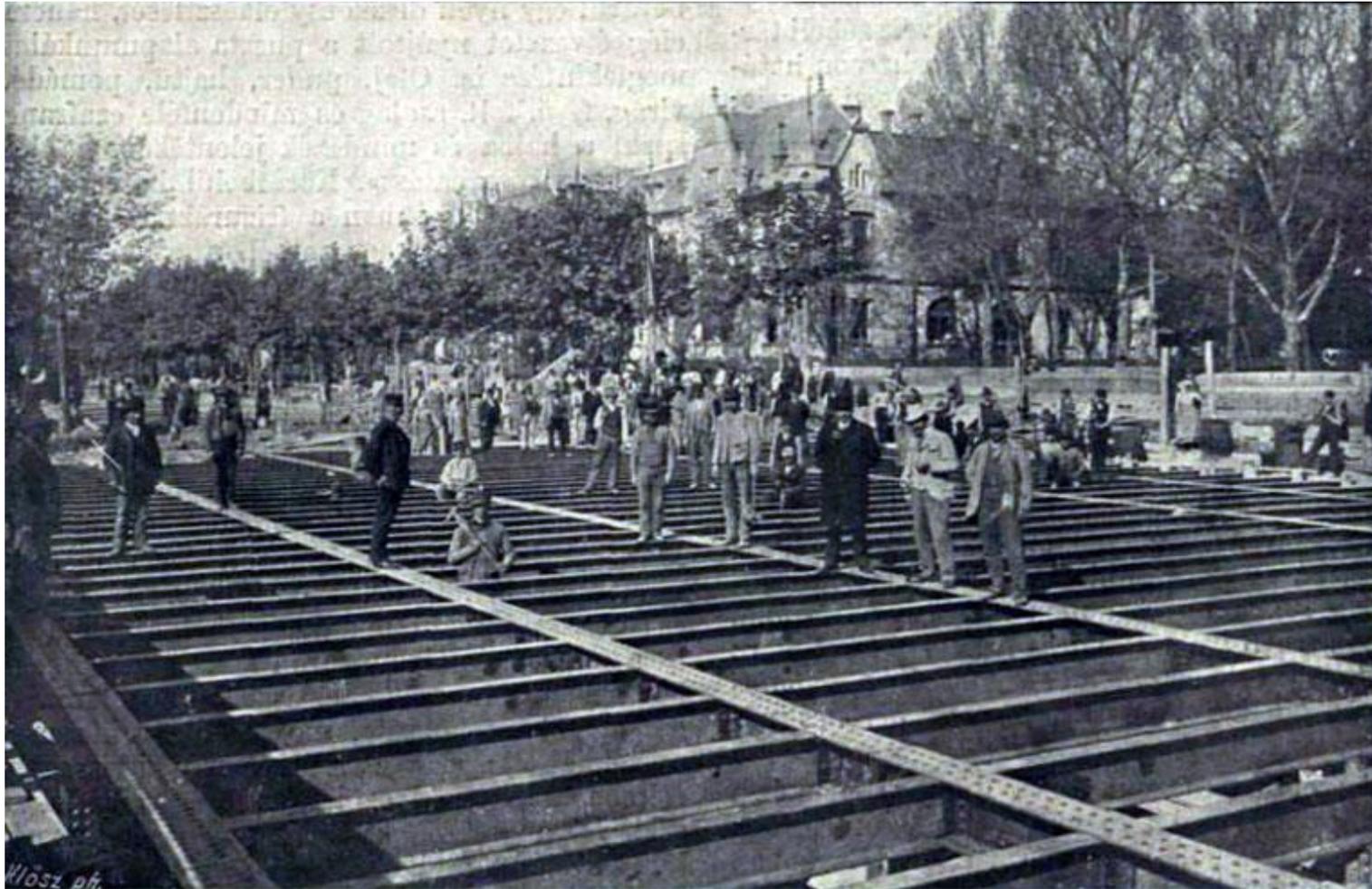
The tunnel

- The tunnel was made by “dig and cover” technique
- Two shifts with man and horse power. At the night shift electrical arc lightings were used.
- A total of 138,000 cubic meters of soil were excavated by hand, and 47,000 cubic meters of cement and 3,000 tons of iron were required for the support structure
- The leaking water was trapped into collecting wells and was pumped up by electric suction pumps.
- The construction works (3.22km tunnels with 9 stops and 0.46 km line on the surface with 2 stops)
- The inner height of the tunnel is 2,65 m (3,5 m till the surface), it is limited by the crossing of the main sewage canal. The average width is 6 m.

Tunel digging



Covering



Surface section and bridge



- During the construction new materials were used. The concrete strengthened by iron was the invention of *Robert Wünsch*. The tunnel walls, the slab and a small bridge are built of ferroconcrete. The concrete was mixed by electrical mixers.

Carriages

- The initial common fleet of the two operators consisted of 10 yellow metal covered carriages of *Budapesti Villamos Városi Vasút (BVVV)* and
- 10 brown wood covered railway carriages of *Budapesti Közúti Vaspálya Társaság (BKVT)*. The royal carriage
- No. 20. had extra solutions with a saloon. It was used by Kaiser Franz Joseph, King Carl IV., Kaiser Wilhelm, etc.
- Trailers from 1950

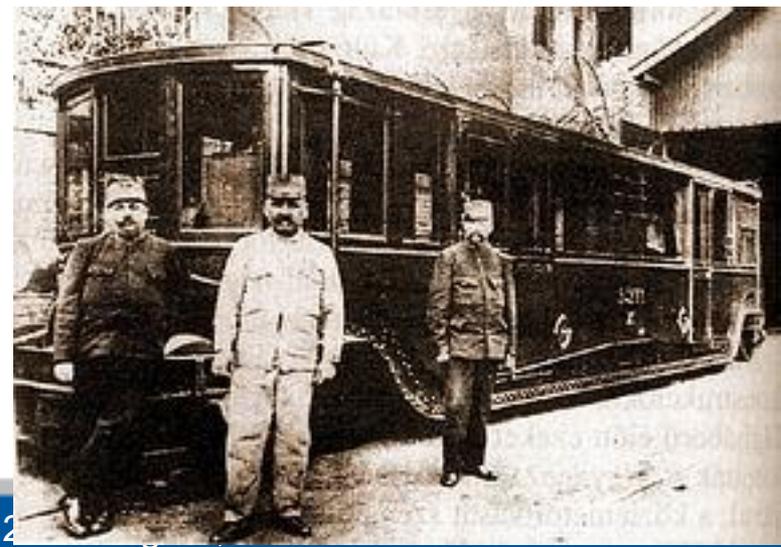
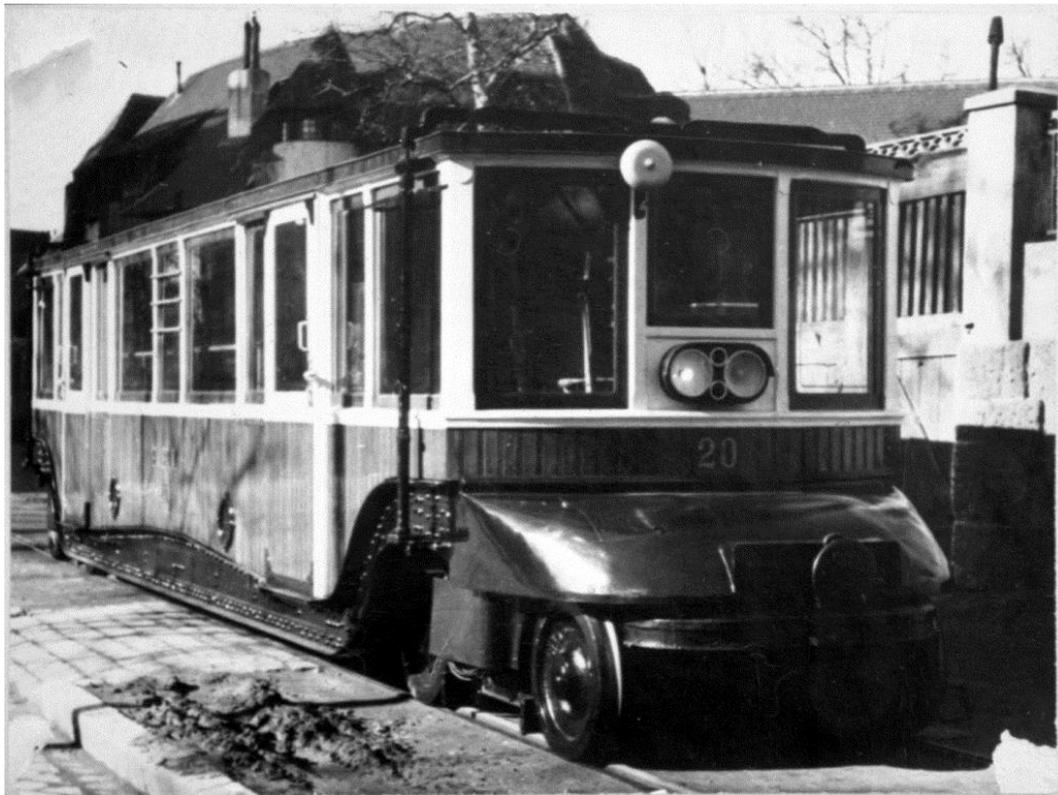
Metal covered, No. 1.



Wood covered, No.19.



The royal wagon, No. 20.



Trailers

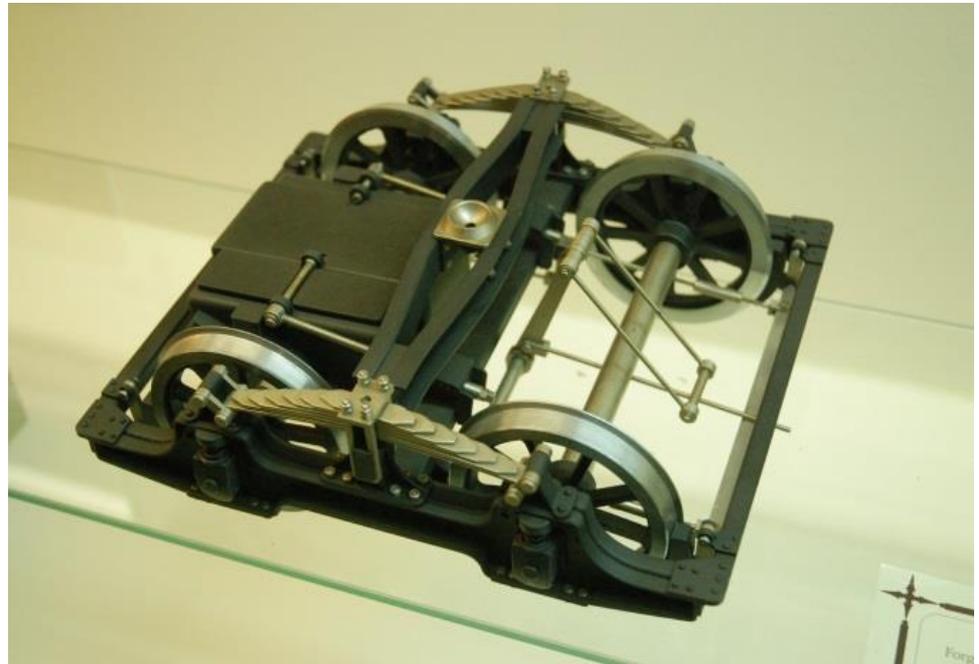


Technical data

- Each railcar could accommodate 28 seated and 14 standing passengers.
- The original metal coated railcars had 11,77 kW LDo motors with Gall-chain for driving 650 mm diameter wheels.
- The old wood covering rail cars had 14,71 kW B 22/30 motors mounted on wheel-set axles with 800 mm diameter wheels

Bogie and producers

- Bogie carriages were produced by *Schlick Vasöntöde és Gépgyár (Schlick Forgery and Machine Factory)*, and the electric devices were made by *Siemens und Halske Co.*



Stations

journey time in min	stops	remarks
0	Vörösmarty tér	Gizella square (nowadays Vörösmarty square)
1	Deák Ferenc tér	Deák Ferenc square
2	Bajcsy-Zsilinszky út	Váci avenue (nowadays Bajcsy-Zsilinszky avenue)
3	Opera	Opera (Fig. 13. and 14.)
4	Oktogon	Oktogon square
5	Vörösmarty utca	Vörösmarty street
6	Kodály körönd	Körönd (Kodály roundabout)
7	Bajza utca	Bajza street
8	Hősök tere	Aréna street (nowadays Heroes' square)
9	Széchenyi fürdő	Zoo (surface section - abandoned)
11	Mexikói út – new underground terminal	Artézi bath (surface section – abandoned, nowadays Széchenyi bath)



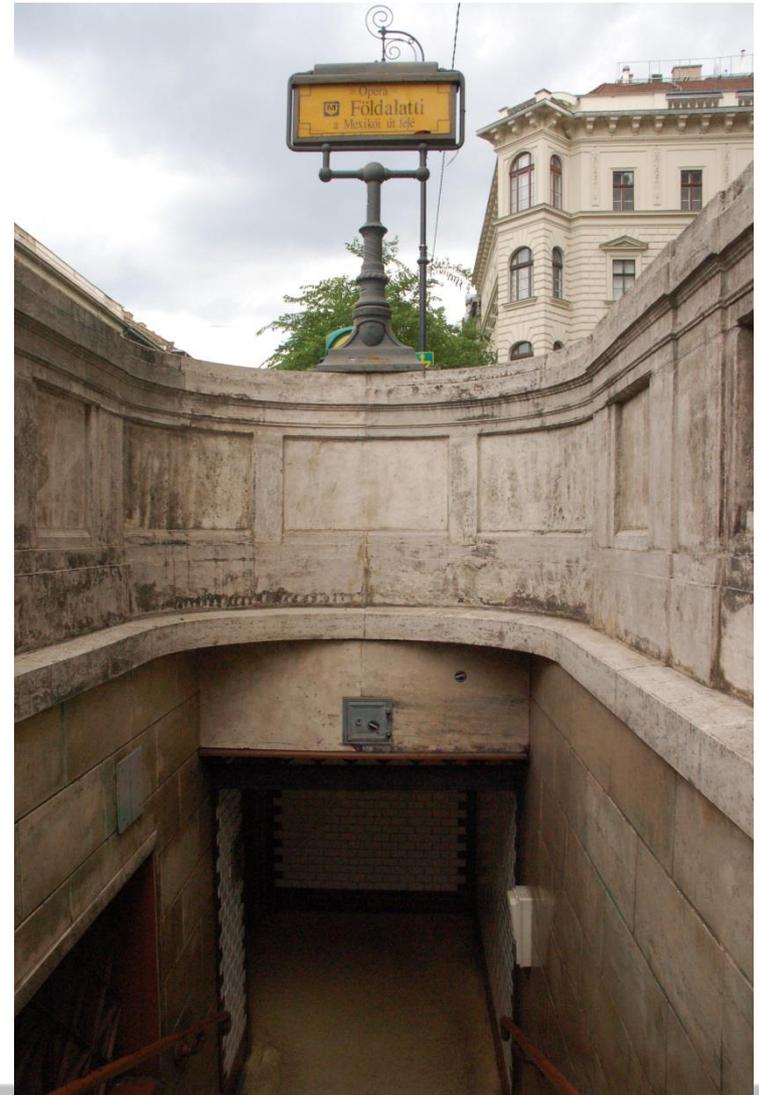
- The line has 8 original and 3 newly made underground stations

Old Stations



- Above the underground station attractive entrance halls designed by *György Brügge* and “*Schickendanz et Herczog*” were erected.

Today



Stations



- The ferroconcrete ceiling is supported by riveted iron pillars. In 1995 the stations were renovated, fixed, insulated and dyed by anticorrosive painting.



Stations

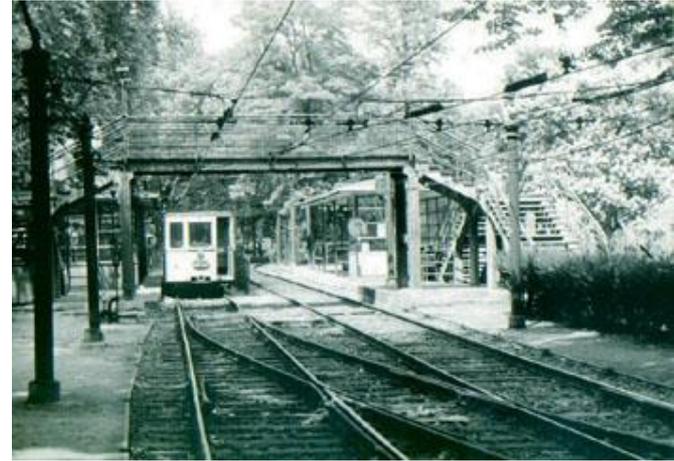


- The walls of the 8 old stations are covered by porcelain ceramics produced by the *Zsolnay Factory* in Pécs, Hungary.

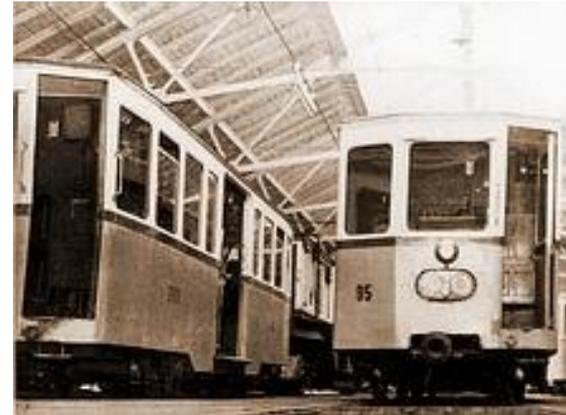
The track

- The 1435 mm gauge track was built from iron cross-ties '*Banovits system*' containing asymmetric *Vignoles* rails (24,2 kg/m) that were connected with lap-seams (patent of *Hartman*). This solution provided noiseless traffic not to disturb the promenade on the surface, the inhabitants and it saved the motors.
- The *Siemens-Halske* signalization system showed red light if a train was in the next tunnel section. Free way was signalized by white light.
- In 1995 the rails were changed to 48kg/m *Vignoles* rails, the old wooden sleeps were re-sleepered by concrete holders (makes more noise).

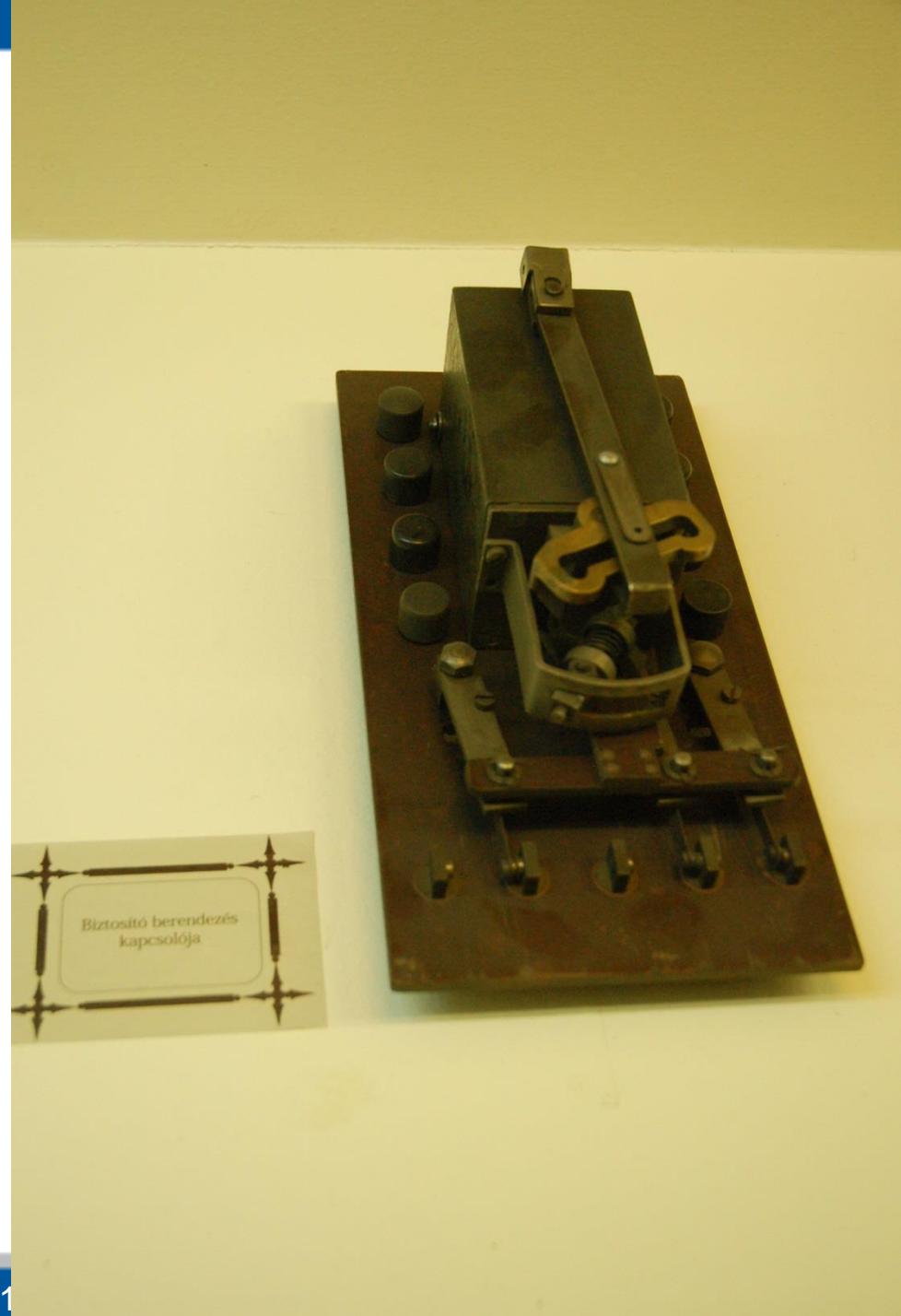
The track



The depot



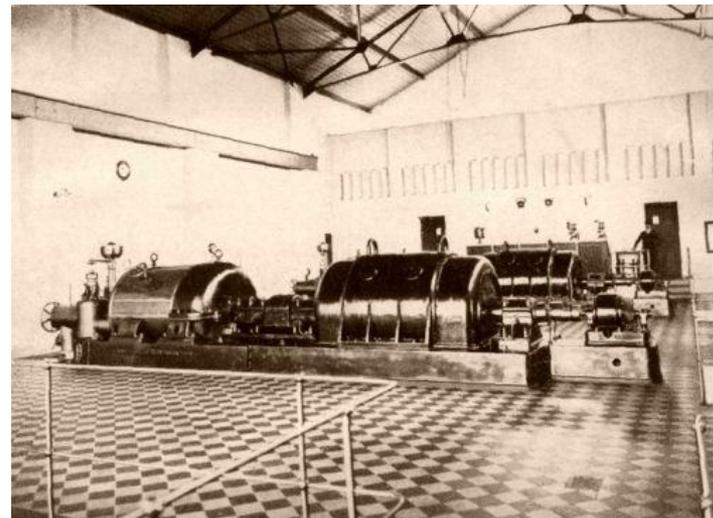
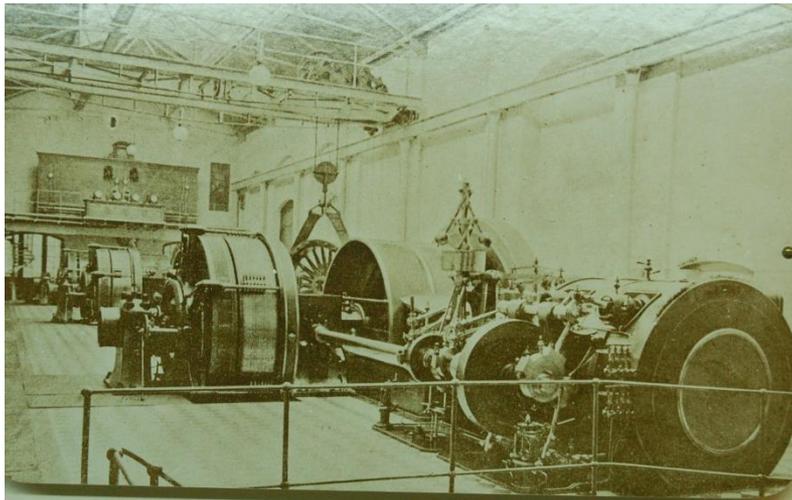
Safety switch



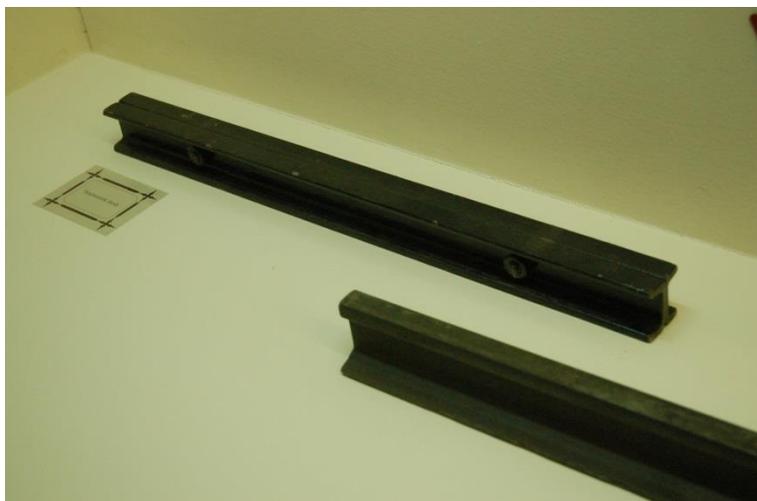
Power supply

- In an early plan three rails were designed for lower current collector, but this idea was later abandoned.
- The 350 V DC hauling current was generated in the '*Kertész utca – Gartner strasse*' (*Akácfa utca*) power station.
- The overhead supply was solved by 50 mm height two-pole double rails (used in mines).
- In the twenties the supply voltage was raised to 550 V DC (nom. 600 V) and the double upper feeder rails was changed to a similar, single feeder rail with single pole feeding and lower rail feed-back

Old steam powered machines

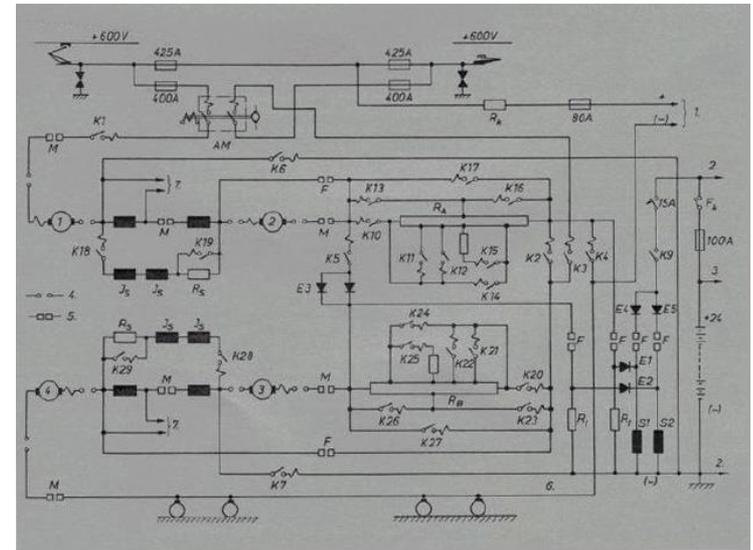


Upper feeding rails

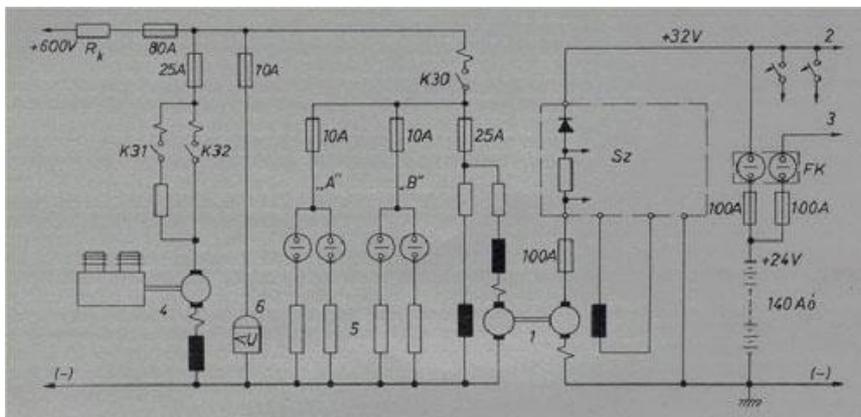


Present electrical circuit of the carriages

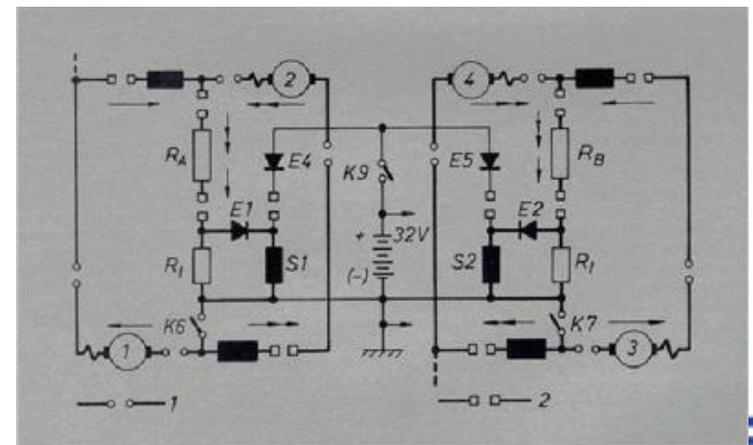
Mains



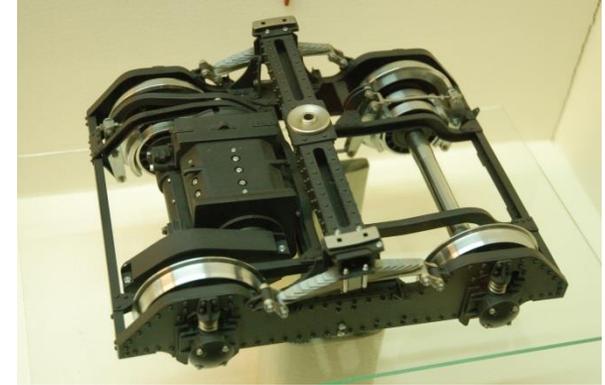
Auxiliaries



Brakes



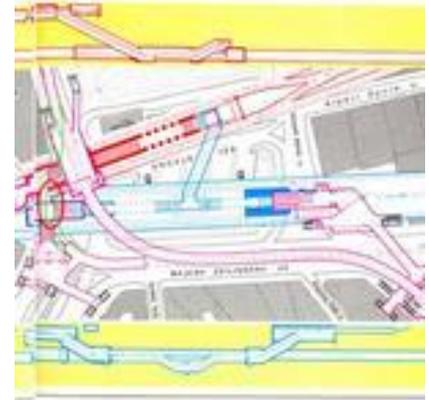
Present wheels and bogies



Renewal after 77 years of operation, in 1973

- At the beginning of the seventies the emerging traffic of Budapest, the connection to the new metro line No.2. and the aged old line required further renovation.
- For the 100th anniversary of the unification of Buda, Pest and Óbuda (birthday of Budapest) the metro line No.1. was rejuvenated.
- In the reconstruction process the tracks, electricity system, carriages were changed. Also the tunnel, the stations were renewed in its original artistic design.
- The traffic changed from the original 'keep to left' to the 'keep to right'. For housing a new, larger shed was built on a new site.
- Two new stations were erected and the former non underground section was pushed down to new tunnel

3 new stations, new shed, new track



Renewals – articulated carriages

- After 75 years of operation from 1971-73 and 1987 the railcars were changed. The new 23 tripartite railcars were designed and build by the Hungarian Ganz Villamossági Művek (Ganz Electrical Works) and Ganz-MÁVAG (Ganz Hungarian General Wagon and Machinery Factory) in Budapest, Hungary. The Ganz articulated railcar available for 190 passengers is tracked by four 66 kW TK44 A type hauling motors. Nominal speed is 60 km/h. Total length is 30.37 m , weight is 37 tons, the wheels' diameter is 670 mm.

New articulated carriage



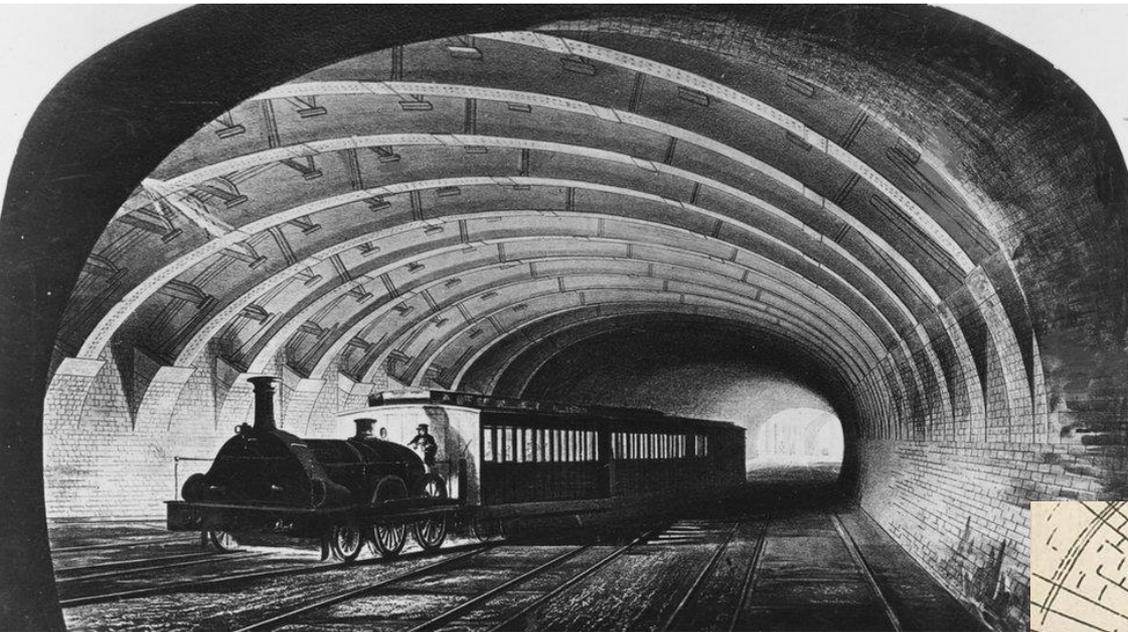
The first electrical underground is in London

The first electrical underground in the continent is in Budapest

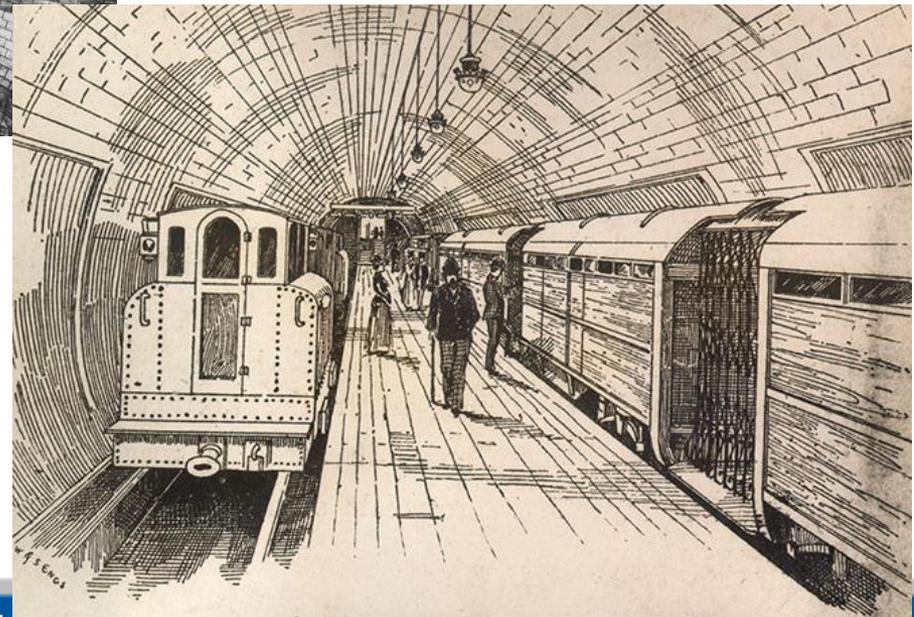
- The **first underground** line in the world the London metro was powered by **steam** engine. It was changed to electric only a decade later, in 1907.
- The London Underground began operating **electric services** using a fourth rail system in **1890** on the City and South London Railway (C&SLR), now part of the Northern line, between Stockwell and King William Street station. This is **the first electrical underground metro in the world.**
- The prime-metro of Chicago began revenue service on June 6th of 1892 by a small steam locomotive pulling four wooden coaches. In 1893, trains began running on the Lake Street Elevated Railroad and in 1895 on the Metropolitan West Side Elevated. The Metropolitan was the United States' **first** non-exhibition rapid transit system powered by **electric traction** motors. **But** it wasn't underground...



London



1863



1890

Project on time and new materials

- A huge project that ended
 - in the time frame (21 months!) and
 - within the planned budget

- New materials
 - Ferroconcrete with large scale iron beams

- New technical solutions
 - upper current collector

In operation

- In operation since 1896
- The original carriages were used till 1973
- One of them operates as nostalgia wagon



Existing museum

- From the fifties a 40 m long part of the old tunnel was separated and closed. In 1973 it was converted into the museum of the first Budapest underground metro



Recommendation to mark as IEEE milestone

- There is no other operating oldshape early electrified metro line
- There is no metro milestone in the IEEE palette
- IEEE Hungary Section is proud of the success of the ancestors

Thanks for the attention!

Welcome to Budapest!

