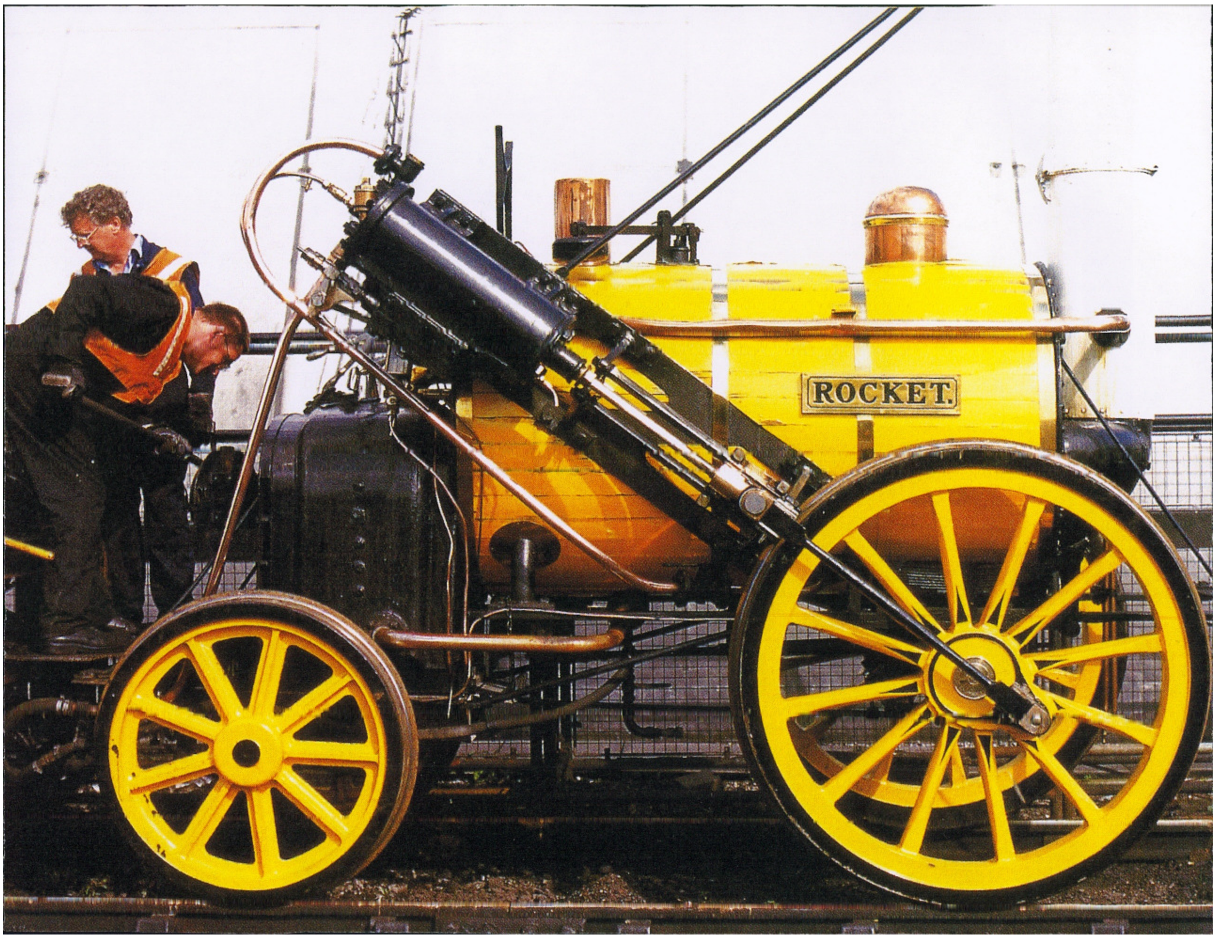
“HIGH-SPEED-RAIL”

FROM THE “ROCKET” TO THE “BULLET”

The Speed-Race on Rail in 178 years from 50 to 574.8 kmph

Elaborated for a Technical Railway Exhibition and Seminar with Students of the Richmond Hill College, Galle, Sri Lanka, October 2014



Replica of the 1829 “ROCKET”, York National Railway Museum, UK

elaborated by Dr. F. Wingler, revised July 2016

“HIGH-SPEED-RAIL”

FROM THE “ROCKET” TO THE “BULLET”

SPEED, HIGHER SPEED, SEMI-HIGH SPEED, HIGH-SPEED, VERY-HIGH-SPEED ON RAIL

WHO IS THE FASTEST?; The Period from 1829 to 1964

October 1829 ***ROBERT STEPHENSON*** won a competition with his steam locomotive ***„ROCKET“*** at Rainhill near Liverpool in England as the builder of the most reliable steam-locomotive. He reached a speed of 42 kmph. Later this locomotive reached near Manchester 50 kmph; **Pict. 1, 2; Pict. Gallery**.

The locomotive ***„ADLER“,*** build in the Stephenson’s locomotive factory in England and delivered to Germany for the first German rail road Nürnberg-Fürth, reached on 16th November 1831 65 kmph. End of the 19th century the ***„CRAMPTON“,*** a Locomotive with a 2.30 m driven wheel, run already 120 kmph, **Pict 3; Pict. Gallery**, and a French Steam Locomotive should have reached 1890 between Paris and Larode 132 kmph.

The Steam Locomotive Manufacturer ***MAFFEI*** in Munich, Germany, pushed the race for **HIGHER SPEED** of Steam Locomotives 1902 with a 2´B1´ Locomotive, build with 2.2 meter wheels for the Badenia Railway, to the mark of 144 kmph and with a similar 2´B2´ Locomotive for the Bavarian Railway on 02nd July 1907 to the that time world record of 154.5 kmph; **Pict. 4, 5; Pict. Gallery.**

It had been demonstrated 1903 that with the Rail-Wheel-System **HIGH-SPEED** over 200 kmph is possible. On 27th October 1903 the ***„World-Speed Record“*** for Rail-Vehicles reached 210 kmph with an electrical, three-phase Tram-Rail-Car on a specially prepared 25 km test-track between Marienfelde and Zossen, Berlin, in Germany; **Pict. 6; Pict. Gallery.**

Professor Franz Kruckenberg, the Pioneer of HIGH-SPEED-RAIL TECHNOLOGY & SERVICE

The Pioneer and Forth-runner of **HIGH-SPEED Rail Service** in Europe had been the Engineer Professor ***FRANZ KRUCKENBERG***, 1882-1965. His idea was to use aeroplane technology, and he propelled a Light Weight Rail Car with an Aeroplane Motor and a Propeller. Franz Kruckenberg founded a Company for ***“AERO-TRAIN”*** to study the methodologies and techniques for **HIGH SPEED RAIL VEHICLES.** On 22nd June 1931 his ***„Zeppelin-like“*** Rail-Vehicle reached 230 kmph with a 440 hps petrol motor; **Pict 7,8,9; Pict Gallery**. With the air-screw the technical problems of power transmission between piston-combustion motor and wheel could be circumvented. But he could not convince the German Government Railway to support his idea of an airscrew propelled rail vehicle based on aeroplane technology. The upper echelons in the Government Railway where thinking in a more conventional way.

FRANZ KRUCKENBERG developed and engineered several features for **modern HIGH-SPEED-TRAINS**. He is regarded as the ***"FATHER OF MODERN HIGH- SPEED TRAIN TECHNOLOGY***":

Reduction of the weight, articulated Rail Car Technology with so-called "***Jacob's Bogies"***, where two racks are resting on one bogie, electric welded self supporting

Coach Shells, Rubber-Suspension and Damping and Air Conditioning.

His articulated Diesel-Hydraulic front propelled Proto-Type "***HIGH-SPEED TRAIN"*** reached on 15th Jan. 1937 200 kmph; **Pict.10, 11; Pict. Gallery**. The preparations for World War II stalled the far-sighted developments.

But his pioneer mind inspired as well advocates for Steam-Technology as for Diesel-Engine propelled trains to go for **HIGHER-SPEED.**

In the 1930-ties there had been Developments in USA, England and Germany for fast **INTERCITY-RAIL-SERVICES** with a scheduled speed of 160 kmph or 100 mph. In USA Union Pacific and Burlington introduced ***"STREAMLINER"***, fast running luxury Diesel powered Rail Car Trains running up to 177 kmph. The Burlington ***"ZEPHYR",*** build by **BUDD,** had been in USA a famous fast running luxury Diesel-Rail-Car Train; **Pict. 11b, 11c; Pict. Gallery**.

Based on ideas of Prof. F. Kruckenberg the German Railways established from 1934 onward a fast Intercity-Service with Diesel-Electric and Diesel-Hydraulic propelled articulated Rail Cars. The "***FLYING HAMBURGER***" covered 1936 the distance from Berlin to Hamburg in 2 hours and 10 min. with two stops in between with an average running speed of 137 kmph and a max. Speed of 160 kmph; **Pict. 12, 13,14; Pict. Gallery.**

Advocates for the Steam-Technology envisaged similar performances with Locomotive hauled trains.

In England the famous 2`C1 ***"MALLARD",*** **Pict.15; Pict. Gallery**, touched on a slightly down-gradient run on 03rd July 1938 202.8 kmph after in Germany on 11th May 1938 the three-cylinder 2`C2` ***"05"*** had touched 200.4 kmph on a flat land run. The British Record-Locomotive is exhibited in the York Railway Museum and the German Record-Locomotive in the Nürnberg Railway Museum; **Pict.16; Pict. Gallery**. The British claim the **"STEAM-WORLD-RECORD"** for themselves. But unofficially the records had been exceeded in USA by a Pennsylvania Rail Road Class S1 3`B B 3` four-cylinder Steam Locomotive with up to 240 kmph; **Pict. 17; Pict. Gallery**. Later the US-Government prohibited such **HIGH-SPEED-STEAM RUNS** for safety reason. The fastest passenger trains before World War II had been 1935 the so-called "***HIAWATHA STEAM TRAINS"*** between **CHICAGO** and **MILWAUKEE/St.PAUL** running up to 200 kmph.

For redundancy to the Intercity Diesel propelled Rail Cars in Germany two 175 kmph Tender-Steam Locomotives with 2.20 metre wheels of the Class ***"61"*** had been build to haul a special luxury business Intercity Train between Dresden and Berlin;

Pict.18; Pict Gallery. The coaches and one Locomotive survived the World War II. The coaches are nowadays used for nostalgic train rides and one of the surviving Locomotive had been modified in East Germany with a longer boiler and an extra coal tender and joined with the Class ***"18"***. The No.1802, the metamorphosis of the Class ***"61",*** has a private ownership in Germany and is still in running condition and with 175 kmph at present the fastest Steam Locomotive on the globe in working condition.

One of the major disadvantages of Steam Locomotives is the heavy moving mass of piston, crank shafts, connecting rods and the heavy wheels of great diameter. During World War II Henschel engineers in Germany designed 1940 a stream-lined Steam Locomotive for **HIGHER SPEED** with so-called ***"STEAM MOTORS"*** assembled with two cylinders on each axle with wheels of 1.25 meter diameter – the feature of the Stephenson "***ROCKET"*** from 1829; **Pict. 19, 20, 21a/b; Pict. Gallery*.*** World War II stalled this technology. On 13th October 1944 the Locomotives got badly damaged by a war-bomb. After the war in August 1945 the Steam Motor Locomotive had been repaired by Henschel and taken by the American Army to America, but 1952 unfortunately scrapped in Fort Eustis, Virginia, USA. Railway Enthusiasts are sad, that this Locomotive Class ***"19"*** got lost as a historical technical monument for a museum. Any way. he technology of High Performance Diesel Motors and better Electric Traction Transmission had made this **STEAM MOTOR DEVELOPMENT** obsolete.

After World War II the conditions have drastically changed.

In America the Rail Passenger Services declined rapidly in favour to Road and Air Traffic. Europe had been occupied to repair the damages of the World War II and to get the trains running again with moderate speed. After World War II back in 1976 British Rail was the first operator to refresh **HIGHER-SPEED** in Europe by launching Diesel powered Rail Service with 200 kmph on upgraded tracks.

HIGH-SPEED-RAIL ON DEDICATED PASSENGER-ONLY STANDART GAUGE RAIL ROADS STARTED 1964 IN JAPAN

The ***"Standard Gauge"*** in England, America, China and on the European Continent is 1.435 meter (4ft 8 ½ inch), the heritage from England exported by Stephenson with his steam locomotives. In Russia trains are running on a broader gauge of 1.524 meter or 5 ft (Russian Broad Gauge) and in Spain and Portugal with 5 ft 6 inch, (Iberian Broad Gauge; 1.668 m; Indian Broad Gauge: 1.676).

All new dedicated Mining Rail Roads in Africa and Australia are nowadays build in 1.435m gauge. China is building its new Railroad from the new Standard Gauge railhead Kunming to Myanmar in 1.435 gauge in order to have a direct access to the Indian Ocean via the Bengal Gulf for shipping routes via **SRI LANKA-HAMBANTOTA (as supply station)** to **AFRICA** and via the Suez-Channel to
EUROPE; Pict. 22, Pict. Gallery. China is building in Sri Lanka the new freight-container rail-track (in Indian-Broad-Gauge) from Hambantota via Beliatte to the Coast-Line-Terminal **MATARA** as a freight-link to the **COLOMBO-HARBOUR.** The

land for the freight rail-terminal south of MATARA RLW- Station is already cleared, and the earth work up to Beliatte iis n progress.

For economical reason in **JAPAN** the Railway Lines had been build in 1 meter Narrow Gauge. In the 1940-ties a new dedicated passenger line for 150 kmph in the heavily populated area between TOKYO and SHIMONOSEK had been envisaged. World War II stalled this project.

This plan had been renewed 1995 but with a special engineered dedicated passenger-only 1.435 m Standard Gauge for Electric powered **"HIGH-SPEED"** with envisaged 210 kmph. Decisive for **HIGH-SPEED on RAILS** have been the **CONTINOUS WELDED RAIL TRACKS** on well ballasted **CONCRETE SLEEPERS.** The line from **TOKYO to SHIN-OSAKA** - the world's first purpose-build **HIGH-SPEED-RAILWAY** - had been opened in October 1964 as a "**PASSENGER-ONLY-LINE"; Pict. 23; Pict. Gallery**. Since the trains are running on a new dedicated passenger track, a wider loading gauge of 3.30 metre could be used for higher comfort of the passengers. In Europe the width of the rolling stocks are limited with 2.8 to 2.9 meter because of the existing old infrastructures.

The Japanese **HIGH-SPEED-TRAINS** are electric driven Tram-like Railcars on conventional two-bogie coach-structures. The 515 km standard-gauge Railway revolutionised rail travel in Japan and sparked off the construction of **HIGH-SPEED-RAIL-NETWORKS** around the globe.

A new race for ***RAIL WORLD SPEED RECORDS*** had been triggered off:

On a test-run the SHINKANSEN STAR 21 reached 1993 425 kmph, after tin 1988 the German ICE-1 had pushed the record mark to 406.9 kmph. And finally a special prepared TGV reached in France on 03-04-2007 the record mark of 574,8 kmph; see **Pict. Gallery Pict. 39.**

For aerodynamics in order to reduce the air resistance the Japanese front had been shaped like a ***"BULLET***"; **Pict. 24; Pict. Gallery**. That is why in many countries **HIGH- SPEED TRAINS** are called ***"BULLET-TRAINS".*** This denomination is derived from the ***"TOKAIDO-SHINKANSEN".***

When the Shinkansen line opened 50 years ago, the maximum speed was 225 kmph. Up to 1992 the line speed had been increased to 270 kmph; **Pict. 25, 26, 27; Pict. Gallery.**

CRITERIONS FOR HIGH-SPEED and VERY-HIGH-SPEED; SPEED-INCREASE to 400 kmph

Nowadays Trains running faster than 220 kmph are called ***"HIGH-SPEED TRAINS"***. Trains running faster than 300 kmph are called ***"VERY-HIGH-SPEED TRAINS"***. Such trains need a dedicated speed adjusted rail track structure. Conventional track structures with mixed traffic can be **upgraded** up to speeds between 160 and 220 kmph. Such lines one find in England on the East- and West-Coast linking **LONDON** with **SCOTTLAND** and between several towns in Germany. Indian Railways is using nowadays the denomination ***"SEMI-HIGH-SPEED"*** fo a speed increase up to 200 kmph. Short distances between the town-ships and heavy populated areas make it costly to build routes for **HIGH-SPEED-RAIL.**

Modern **HIGH-SPEED** and **VERY-HIGH-SPEED** Tracks are nowadays without ballast. The concrete sleepers are embedded in a cast **CONCRETE-SLAB**. Such tracks are called ***"BALLAST-LESS*** or ***SLAB-TRACKS"***. Ballast-less Tracks retard much better the alignment; **Pict. 28, 29; Pict. Gallery**. But France, Belgium, England (Eurostar-Line) and Korea still are using Ballast Tracks, which need less Initial Investment Cost but over the Life Cycle higher Maintenance Costs.

HIGH- or VERY-HIGH-SPEED Transport is in competition with **AIR-TRAFFIC**. Economics and Users-Benefits are given best in corridors serving a large dense population or on town-links demanding an attractive high train frequency. Another factor which will affect the economic case for **HIGH-SPEED-RAIL** is the relative prosperity of people living along the corridor. The dedicated railroads and rolling stocks need a **HIGH CAPITAL INVESTMENT.** Prosperity allows demanding higher fares for shorter journey times in conjunction with a higher quality service.

High-Speed Rail can only compete in door-to-door travel market if there is convenient acess at each end. Hence the priority must be integration with conventional rail networks and urban public transport

SPEED-INCREASE COSTS MONEY for Capital Investment, for Service and Running Costs and for Energy!! The economical peak is in the region of 330 kmph although the modern technology allows trains to run 400 kmph.

The routes have to be build straight. This demands in hilly terrain Tunnels, Bridges, Viaducts, Cuttings and very often **ELEVATED STRUCTURES; Pict. 30, 31; Pict. Gallery**. Since **HIGH-SPEED-RAIL** is propelled by **ELECTRICITY**, mostly 25 kV AC, 50 or 60 Hz, with overhead centenary, steep gradients are no obstacle any more. The dedicated lines can be designed like a Roller-Coaster-Line like the old Roman Roads in Europe cutting investment costs. The German **HIGH-SPEED TRAINS "ICE 2"** (**I**nter-**C**ity-**E**xperimental) can negotiate with 15000 hps gradients of 1 in 25. (The ruling gradient of the Sri Lanka Upcountry Line is 1 in 44). However the disadvantage is that only special powerful train sets can run on such steep gradient routes and a mixed traffic with conventional trains is not possible. That is the reason, why the French **HIGH SPEED TRAIN SETS**, the ***"Train á Grand Vitesse" "TGV"*** build for flat land routes, can not run in Germany beyond Cologne up to Frankfurt, and why some Locomotive hauled Trans-Europe Trains linking Germany with Austria and Switzerland have to use between Cologne and Frankfurt the old route along the river Rhine.

HIGH-SPEED-RAIL is most competitive with road and air between 500 and 1000 km, provided there are only limited stops in between. The criterions for **HIGH-SPEED-RAIL** are best given in Japan, France, Spain and China.

In **France** the links between the capital **PARIS** and the major other Cities are mostly flat and in the range of 500 to 1000 km. In 1981 France became the second country after Japan to introduce dedicated, passenger-only **HIGH-SPEED-RAIL** from Paris to Lyon**.** But since in Europe the High-Speed Trains have to enter the cities over conventional tracks the width or loading gauge had to be restricted to 2.90 meter.

France operates nowadays on a 7000 km High Speed Network. A specially prepared TGV Train-Set pushed 2007 the **WORLD RECORD** for the **WHEEL-RAIL-SYSTEM** to 574 kmph.

One of the leading Engineering Company for High Speed Trains is ***ALSTOM*** in France. The French ALSTOM- Engineering Concept is based on the **Prof. FRANZ**

KRUCKENBERG features of an articulated train with the so-called **JACOBS-BOGIES**. The articulated concept gives a higher running stability and provides more safety in case of a derailment, and it allows reduced weight. The bogies are the heaviest components of a coach. The disadvantage is that the train sets are fixed and that the coaches can not be easy decoupled and exchanged. The coaches have to be kept shorter, and there is less room for the doors. The French ***TGV, THALYS***, **Pict. 32; Pict. Gallery**, and ***EUROSTAR*** are engineered with the same articulated technology by ALSTOM. They are electric Power-Sets with **LOCOMOTIVE-POWER CARS** on the front and the rear. The articulated design allows less room in the coaches and in consequences provides less passenger comfort.

The German ***SIEMENS ICE-2 and -3 or "VELARO"*** Technology for the world marked left the **KRUCKENBERG** articulated feature and returned to the conventional two-bogie arrangement per coach for better inside comfort; **Pict. 31, 33; Pict. Gallery**. There are no Power-Coaches. The electric traction motors are distributed over all racks. The Siemens trains are tram-like **RAIL CARS.**

After **France** other economical potential countries followed **HIGH-SPEED-RAIL: Spain, China, Germany, Italy, Taiwan, South Korea, Turkey, Sweden and Russia.**

Projects are in the pipeline in countries such as **Iran, India, Malaysia and Saudi Arabia.**

France, Spain and China have overtaken Japan in the **SPEED STAKE** with over 300 kmph. Japan has dropped to the fourth place in the **SPEED-LEAGUE**.

CHINA has mad the fastest progress in building dedicated **HIGH-SPEED-LINES**. It started 2003 to forge ahead with a gigantic construction programme. It has the fastest growing **HIGH-SPEED-RAIL** Network and passed end of 2013 the 10.000 km mark. By 2015 China expects to have 19.000 km and by 2025 to have 38.000 km of High-Speed line in operation. Although 400 kmph is reachable with the latest technology, for economical reason the max. operational speed will be limited to 350 kmph. The China build ,***CSR Qingdao Sifang***, **HIGH-SPEED RAIL-CARS *CRH2*** and ***CRH 380,*** are based on Japan-Technologyof the "BULLET" design; Pict. 34 to 37; Pict. Gallery.

With 350 kmph operational on rails it does not make much economical sense to go for a 540 kmph with a **MAGLEV-SYSTEM; see Pict. 40; Pict. Gallery. In Germany the MAGLEV System is regarded as uneconomical and obsolete.**

Frequent Stops and using conventional lines to reach the City Stations pull down average running times. This is a main bottle-neck problem in Germany with the cities Berlin, Dresden, Hamburg, Cologne, Frankfurt, Mannheim, Stuttgart, Nuremberg and Munich and in Belgium on the line from Liege to Brussels.

The **NEXT GENERATION of HIGH-SPEED-TRAINS** will use probably **DOUBLE DECKER COACHES**. Per train weight more passengers can be transported, and this will save energy, and the length of the train set can be kept limited. In France already a **DOUBLE DECKER TGV "DOUBLEX"** is in service.

Potential industrial countries as England (with exception of the **Eurostar Route** from the Channel-Tunnel through the Kent-Countryside linking Paris and Brussels with London), North and South America have still no dedicated passenger-only **HIGH-SPEED-RAIL.** In **USA** the corridor **LOS ANGELES–SAN FRANCISCO,** in England **LONDON-BIRMINGHAM/MANCHESTER** and in India the corridors **MUMBAI-**

AHMEDABAD and **NEW DELHI-CHANDIGARH** are envisaged for **HIGH-SPEED-RAIL**; **see Map of Pict. 38; Picture Gallery**.

THE GAUGE QUESTION FOR HIGH-SPEED-RAIL.

Japan used the chance to opt for Standard Gauge for the new to build **HIGH-SPEED-RAIL** Network.

Since the available technology for **HIGH-SPEED-RAIL** had been engineered for Standard Gauge, and since **Spain** is connected with the French Standard Gauge Network, Spain started 1992 to build its new High-Speed Rail Network with Standard Gauge for the ALTA ***VELOCIDAD ESPANOLA, AVE*** **System.** Two gauge standards in one country complicate the logistics and interoperability. Some lines in Spain had to be build with an extra third rail as a gauntlet dual gauge track.

India will face the same Gauge-Problem when going for **HIGH-SPEED-RAIL**. The forth runner is the Delhi-Airport Metro build after a long ideological battle in Standard Gauge and not in Broad Gauge. The Indian Broad Gauge is like a ***"SACRED COW"***. The ***"UNI-GAUGE-POLICY"*** has to be abandoned for **HIGH-SPEED-RAIL.**

Since there is no Broad-Gauge **HIGH-SPEED-RAIL** in this world, nobody knows, if **HIGH-SPEED-RAIL** would work properly on the Iberian or Indian Broad Gauge. It looks like, that the ***STEPEHNSON-GAUGE*** is the optimum for **HIGH-SPEED-RAIL** although 1829 nobody even could think of 400 kmph**.**

The fastest trains on **Meter or CAPE (1.067 meter) Gauge** run nowadays with 160 kmph in South Africa. In Germany a Swiss build Diesel rail car designed for Greece reached on **2 ½ feet NARROW GAUGE** 80 kmph on a test run.

There is another problem with HIGH-SPEED-RAIL: The Risk of Collision with animals!

In Germany a High Speed Train derailed at the entrance of a tunnel when colliding with 200 kmph with a sheep flog. The derailed train set scrubbed inside the tunnel along the wall. 20 sheep got killed but luckily no passenger injured.

Fencing a High Speed Railway Line in **India** will not do. People will either loot the fencing material or cut the fences open for private crossings. If **HIGH-SPEED-RAIL** will come to **India** it has to be build on elevated structure, and this will be very costly. Since such **HIGH-SPEED-RAIL** routes can not be used by the other Broad Gauge Trains it is the question if the **HIGH-SPEED-RAIL users in India with relatively low spending power will generate enough revenue to justify the investment of new dedicated routes.** The tendency in India is therefore nowadays to upgrade conventional lines with conventional track technology and infrastructure stepwise from 130 to 200 or 220 kmph ("Semi-High-Speed). For such an "Inter-City-Speed-Up" Spanish Talgo Trains with one wheel-set per coach-shell are under test trial; see "HIGH-SPEED India" in Railway Gazette International, July 2016, p.38; **see Map of Pict. 39; Picture Gallery.**

HOW FAST IS ENOUGH FOR SRI LANKA or WHAT IS POSSIBLE?

Sri Lanka inherited the **BROAD GAUGE** from the great trunk routes in **INDIA** and the **NARROW LOADING GAUGE** for the Rail Vehicles from **ENGLAND**, although Meter Gauge Tracks would have been much more advisable and suitable for the Ceylon terrain and landscape demanding sharp curvatures. Meter Gauge on Ceylon would have made things easier. But the that time engineers thought, the Indian Great-Trunk Broad-Gauge will become the ***"Standard Gauge" of South Asia***; although most railroads in India had been build that time in Meter-Gauge. But this did not realise. The "***Standard Gauge"*** of South Asia became Meter- or Cape-Gauge. In recent decades in India most of the Meter-Gauge lines have been converted to Broad Gauge for interoperability. The Meter and Narrow Gauge disappeared in India; the Standard Gauge is coming.

SRI LANKAN POLICY MAKERS and some **UPPER SLR ECHELONS** are committed to **HIGHER TRAIN SPEED** but lack an idea, how to achieve this and what are the engineering and financial prerequisites. They even speak of ***"HIGH-SPEED"*** when thinking of 100 kmph.

Due to the poor track quality, short distances between halts and railway stations and sharp curvatures trains ply in Sri Lanka only with 50 to 65 kmph, sometimes up to 80 kmph. SLR has no Rail Vehicle with enough haulage traction effort to accelerate a train on short distance to over 100 kmph.

The Railway Lines in Sri Lanka had been once build under the British to transport plantation products to the harbour Colombo. Later the Infrastructures and Townships developed along those lines, once dedicated as freight routes. A major problem is the encroachment and land grab of railway land and the slums alongside the tracks hampering modernisations. To reclaim the lost land and to resettle the people has become a big unsolved political issue.

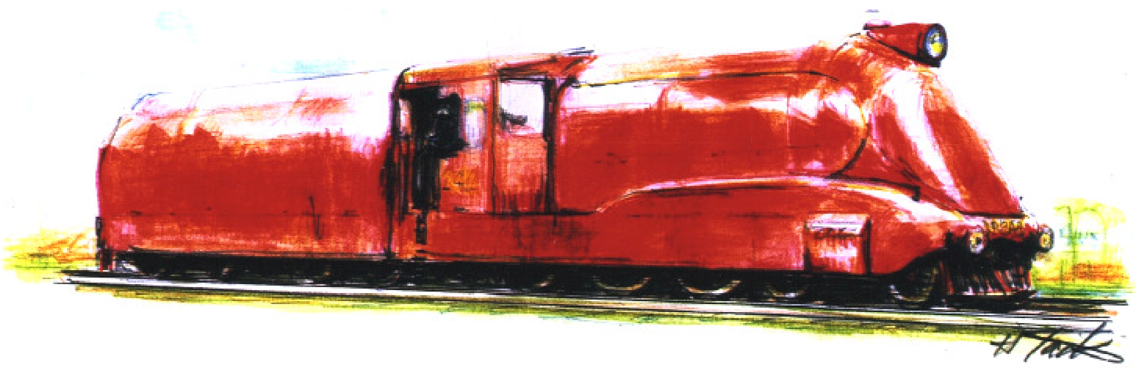
Since, with the renewal of the track from Matara up to Kalutara by IRCON from India the track geometry with its sharp curvatures, encroachments of railway land and land grab alongside, short distances between stations and many level crossings could not be changed, the speed increase due to the better track quality is only marginal in the range of 15 kmph. The max. permissible speed is now 90 kmph on some straight sections. There had been no proper surface water drainage management-programme. The unsolved water problem causes at many spots the memory effects for track misalignments. **Longevity of the Upgrade can not be expected therefore.**

The **prerequisites for 100 to 120 kmph** are level crossing free tracks of a higher alignment quality with low deterioration-rate (loss of the alignment with the time) under given traffic load with curvatures not sharper than 3 (better 2.2) Degree (measured with a 30 meter cord), and a haulage power of the Rail Vehicles over 10 hps per tonne train weight, best 10 to 15 hps, with an acceleration rate of 0.7 m/sec^2. Signalling has also to be adjusted to the speed.

100 to 120 kmph can be achieved in beyond Omanthai on the new IRCON re-build Track up to Jaffna with the China build S12 Power-Set with rear and front power coach. The other Power-Sets with less than 5 hps haulage power per tonne train

weight are underpowered for “***HIGHER SPEED”.* 100 to 120 kmph on the Northern Line will be enough for Sri Lanka.**

1936 CGR dressed a Steam Loco with a streamlined cover. With this appearance it run 20.000 miles; **Pict. 38; Pict. Gallery**. The streamlining had been removed 1937. With a maximum speed of 80 kmph the aerodynamic is of no importance. In 1938 Ceylon Railways achieved two streamlined articulated Power-Sets from England.

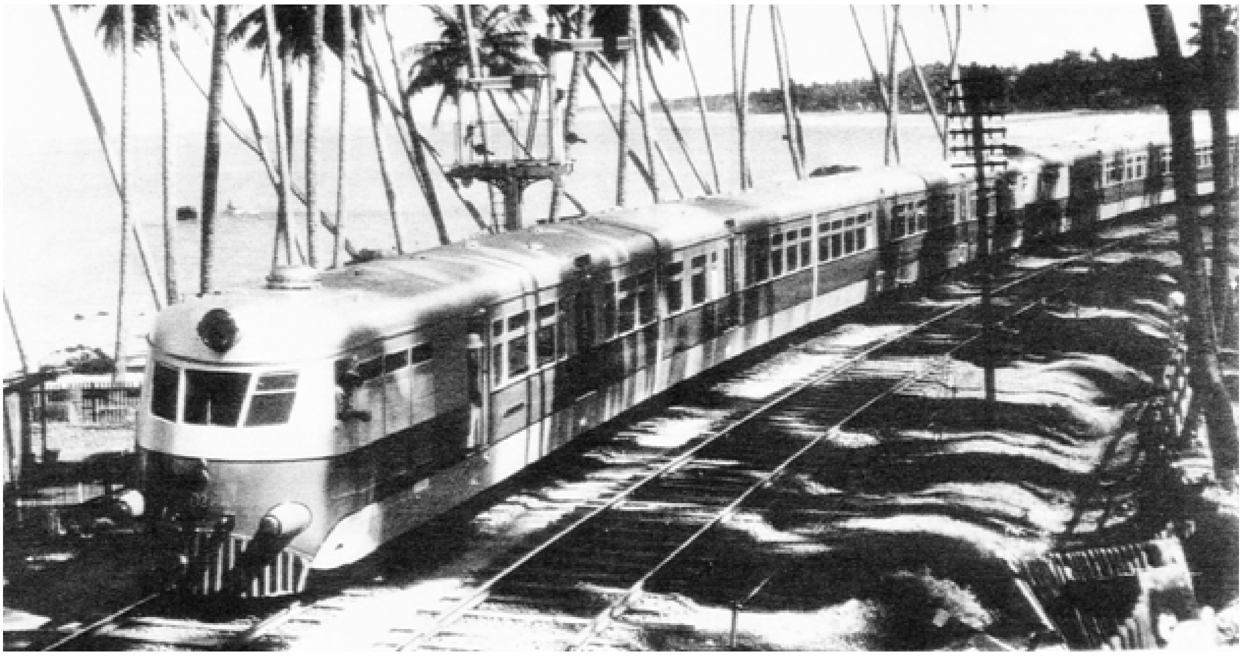


88: STREAMLINED B1 CLASS LOCOMOTIVE NUMBER 242 *SIR EDWARD PAGET*

[Refs: L.A. Nixon, *Railway Magazine*, November 1974; J.C.Young, *ibid.*, February 1938]

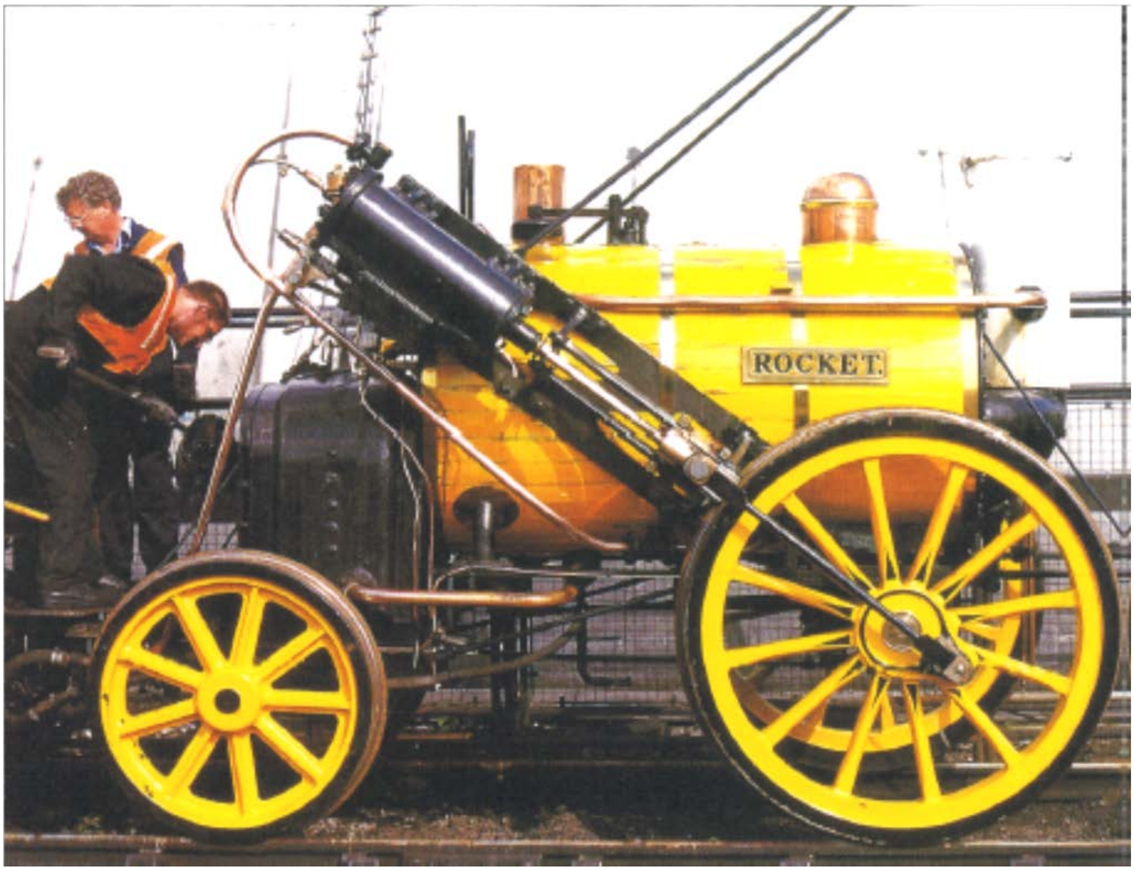
Streamlining was applied to number 242 in 1936. It is difficult to imagine that streamlining was anything more than a novelty – speeds in Sri Lanka are below that at which streamlining becomes important – and it was removed in 1937 after the locomotive had run 20,000 miles in streamlined form, mainly on the Coast and Northern Lines. For the first half of that period, 242 was oil-fired. It was initially turned out in glossy black with a single thin yellow line at the base of the valance and on the sides of the boiler but reliable reports indicate that 242 was later painted Gulf Red, presumably to provide a unified image with the Gulf Red CGR carriages. This superb painting of 242 in its red livery was prepared specially for this book by Hideaki Takaura.

Hideaki Takaura, Jan 2000

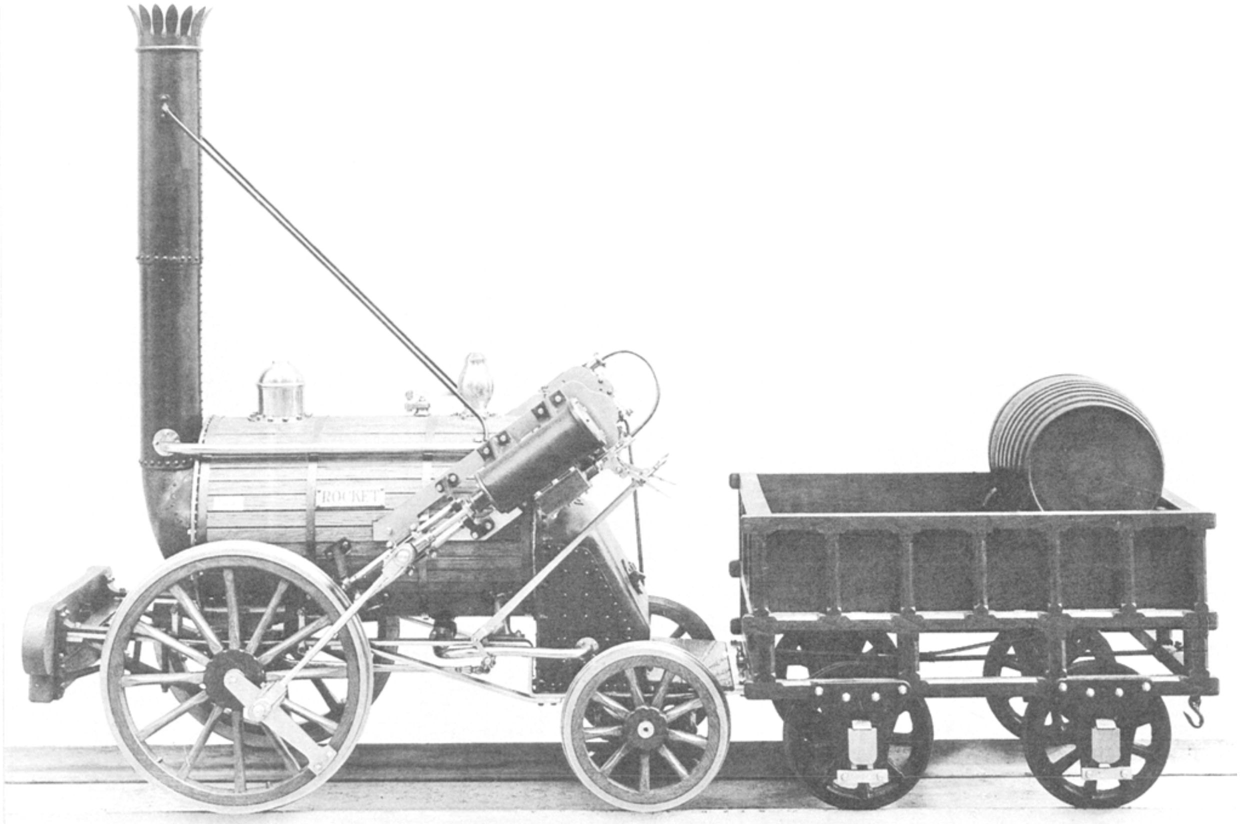


Sri Lanka Railways, Diesel-electric Power-Set, Class S1, powered by two 180 hp Williams Diesel-Engines, build by English Electric 1938, max. Speed 88 kmph; inspired by the German Higher-Speed Train-Set *"Flying Hamburger"*; see Pict. 13; Picture Gallery; withdrawned in 1954 due to heavy Corrosion.

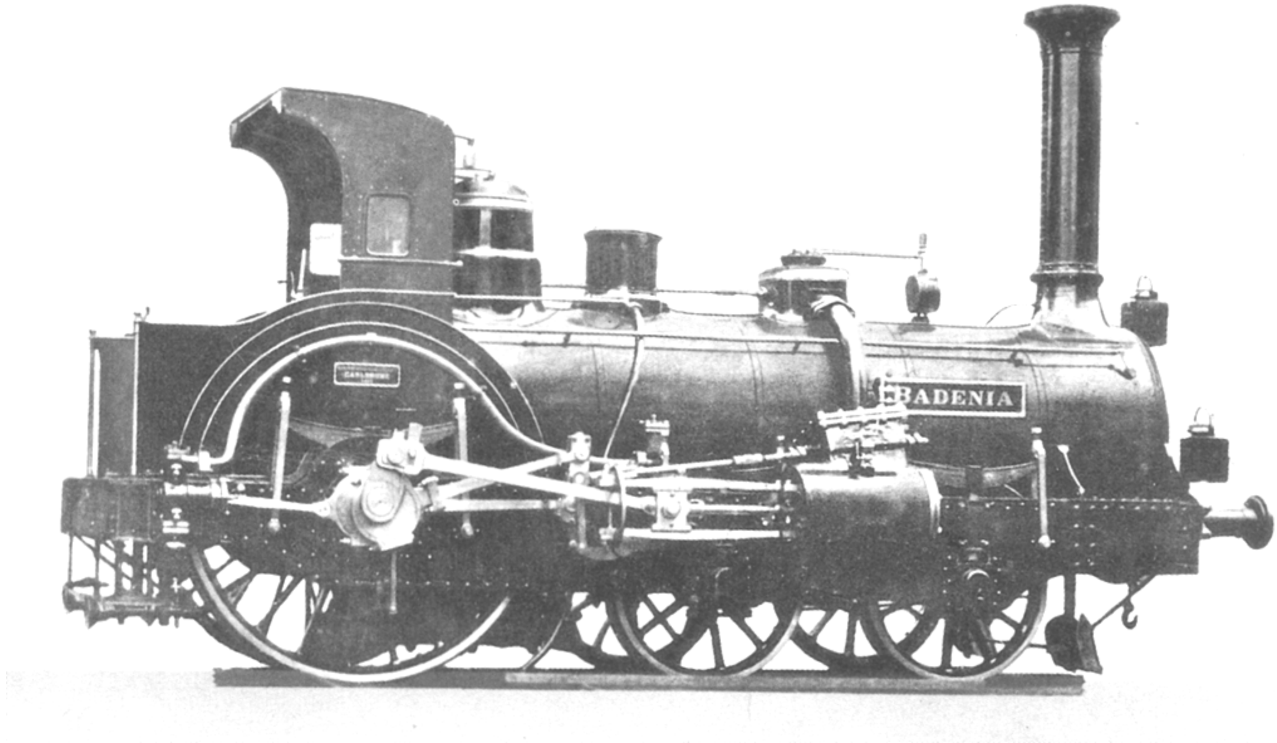
PICTURE GALLERY



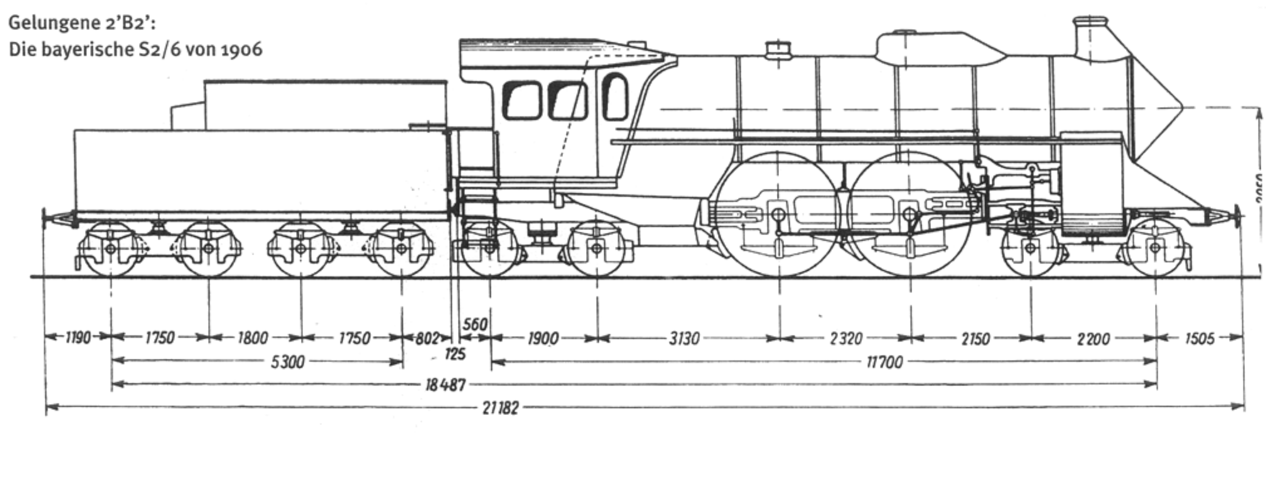
Pict. 1: ***"ROCKET"*** Replica, York National Railway Museum, UK



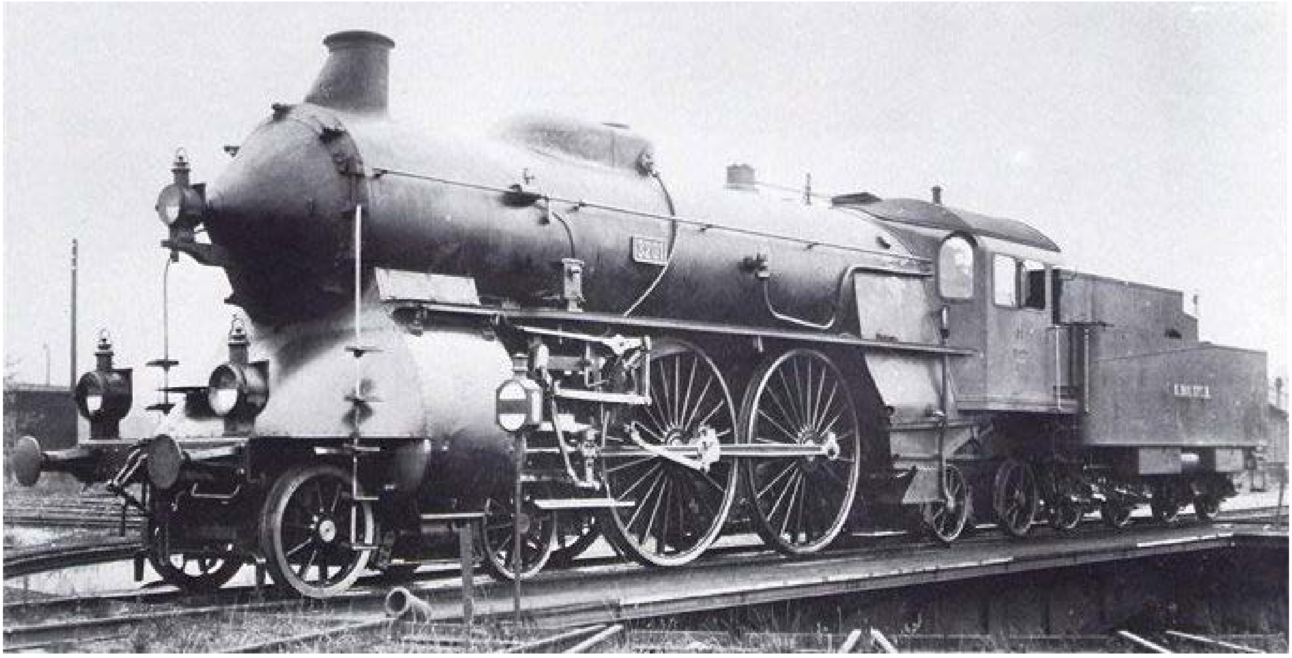
Pict. 2: ***"ROCKET"*** Replica, York National Railway Museum, UK



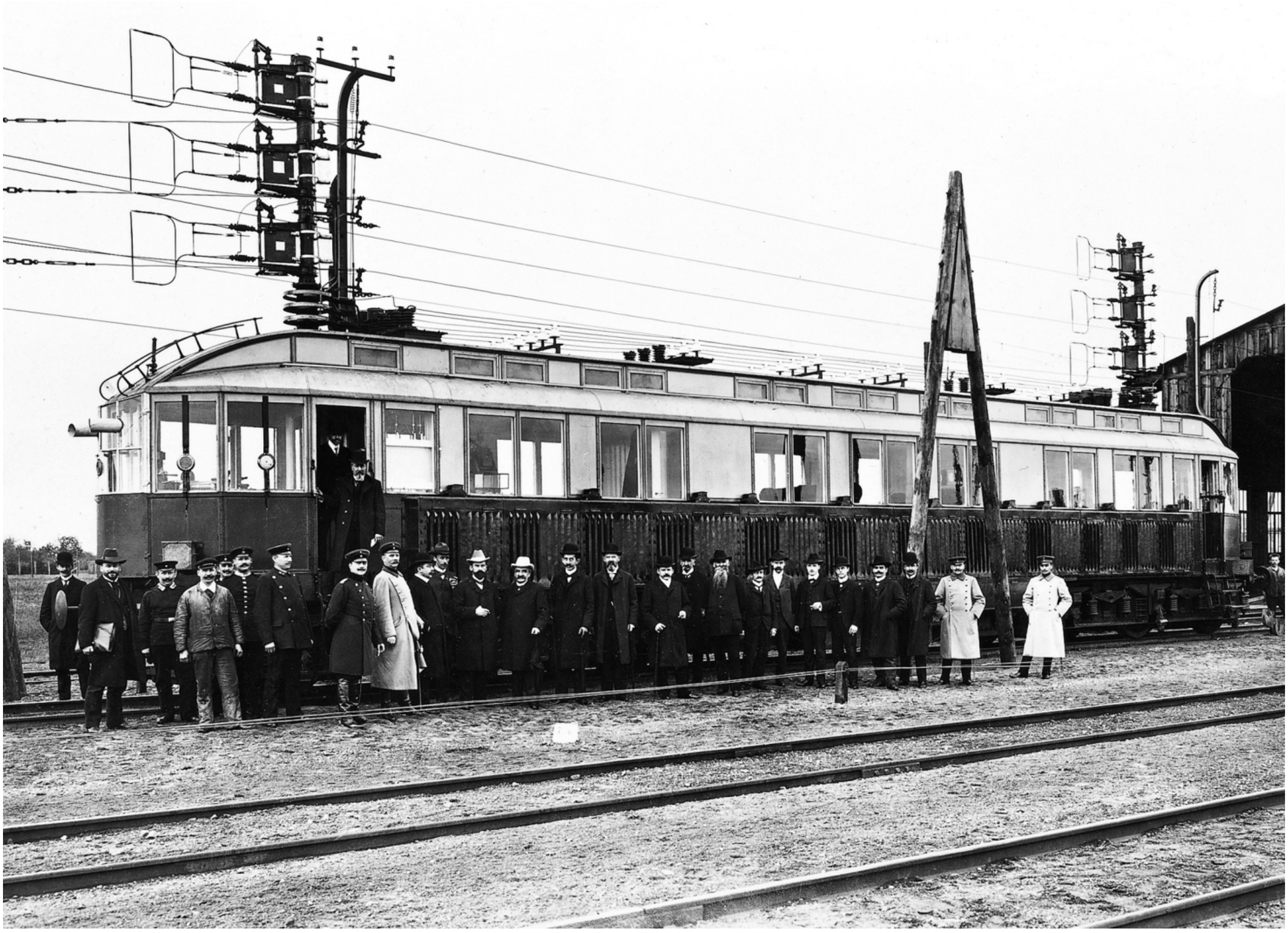
Pict. 3: “CRAMPTON” 120 kmph Steam Locomotive ***“BADENIA”***, end 19th Century



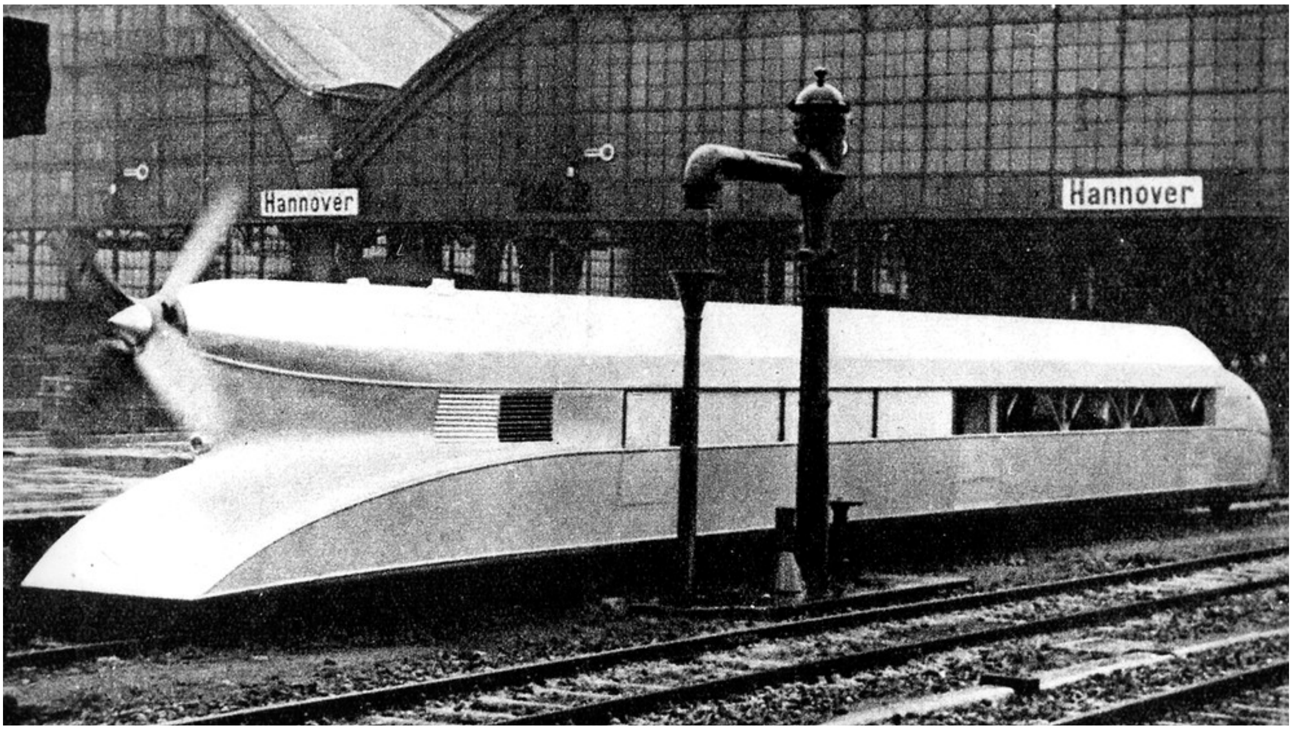
Pict. 4: Drawing of Kraus Maffai 154 kmph Record Locomotive S2/6; 1906



Pict. 5: Kraus Maffei 154 kmph 2`B2` Record Locomotive, 1927

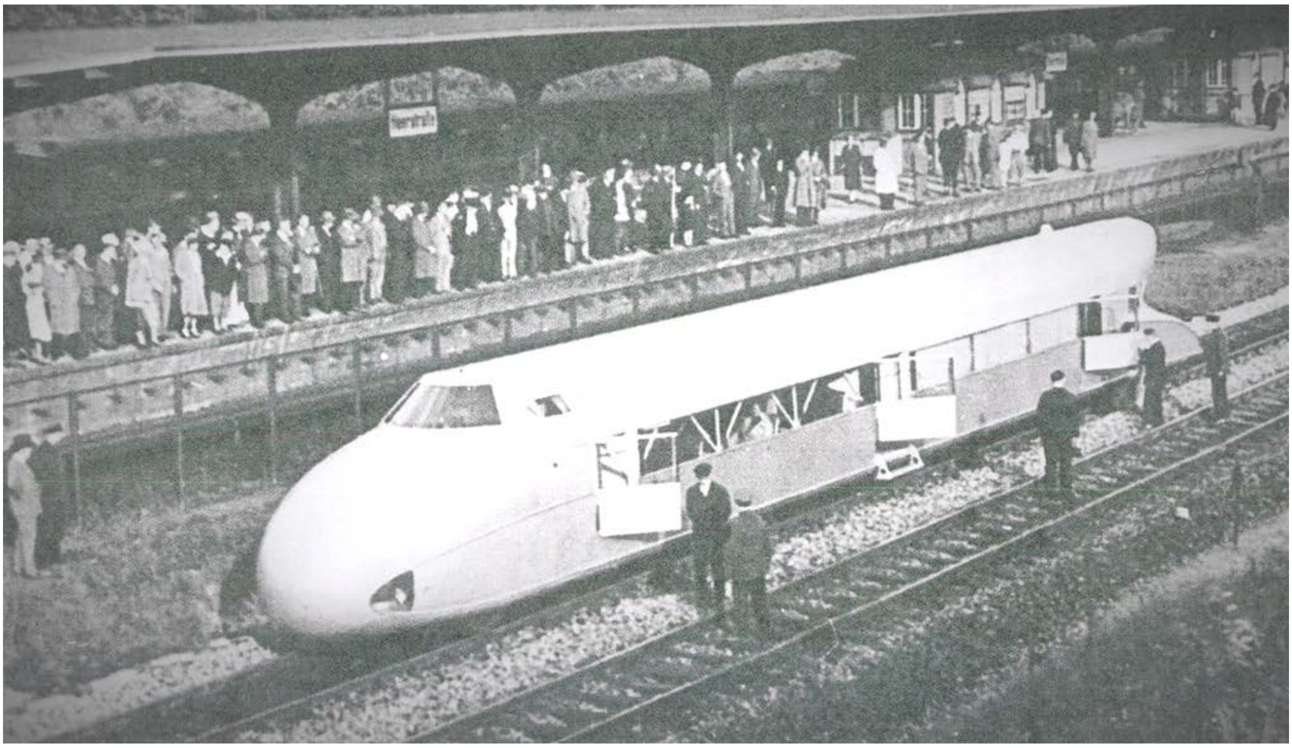


Pict. 6: 210 kmph electric three Phase AC experimental "High-Speed" Tram-Car, 1903

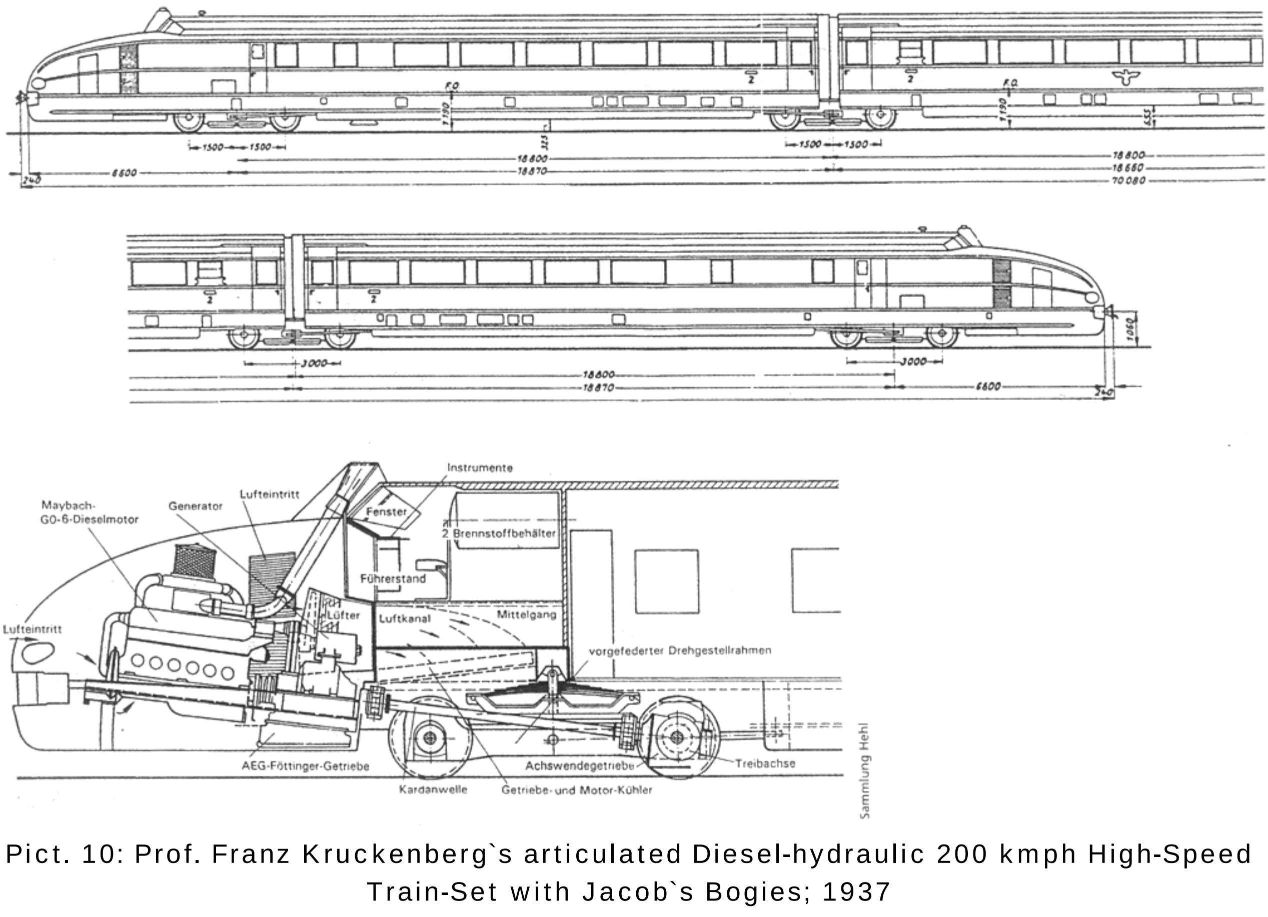


Pict. 7: Prof. F. Kruckenberg 230 kmph High-Speed Aero Rail Car, 1931

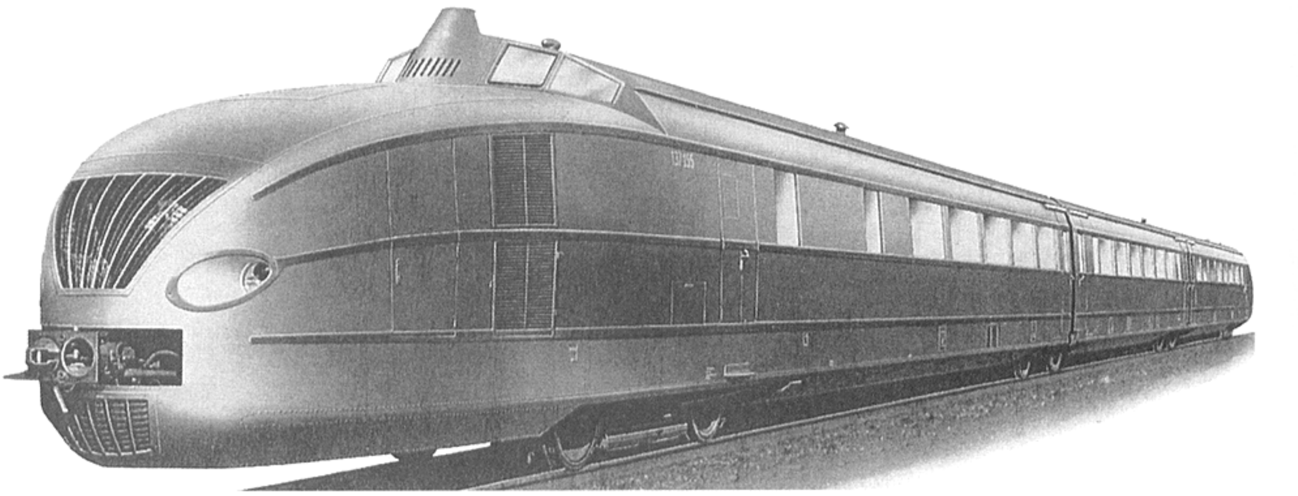
Pict. 8: Prof. F. Kruckenberg 230 kmph High-Speed Aero Rail-Car; 1 in 87 **S**cale Model



Pict. 9: Prof. Franz Kruckenberg`s 230 kmph High-Speed “Aero Rail Car”; 1931

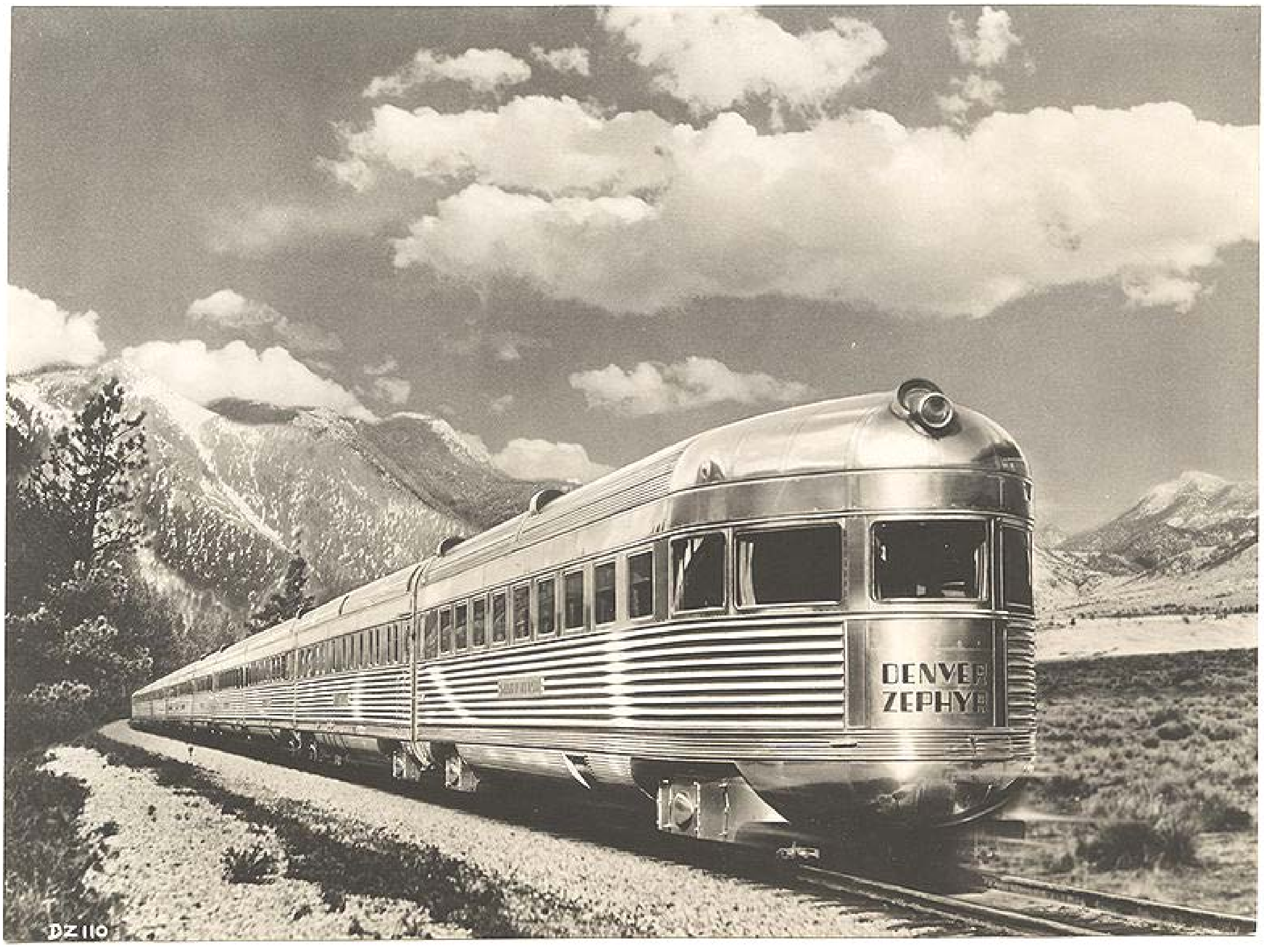


Pict. 10: Prof. Franz Kruckenberg`s articulated Diesel-hydraulic 200 kmph High-Speed Train-Set with Jacob`s Bogies; 1937



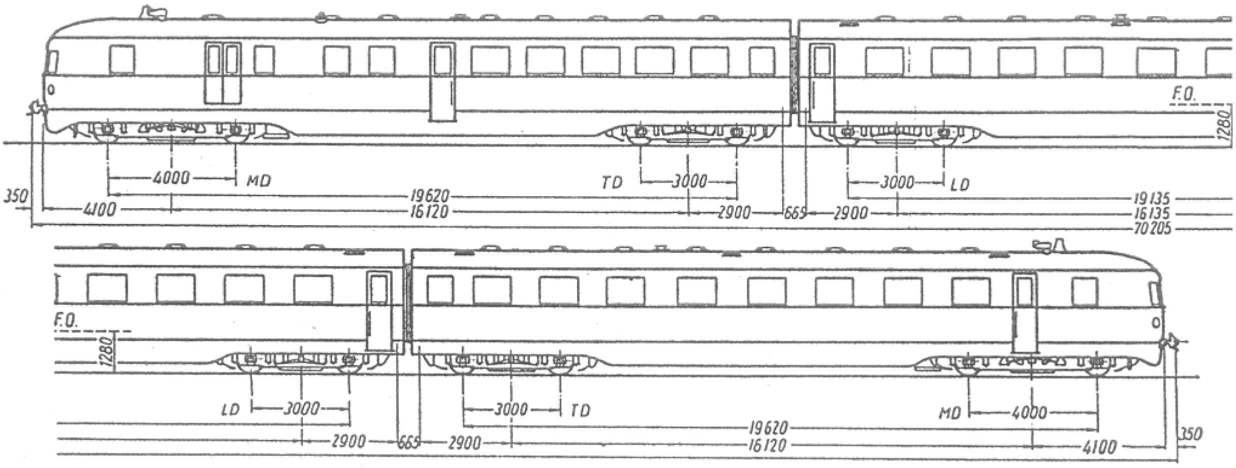
Pict. 11: Prof. F. Kruckenberg articulated Diesel-hydraulic 200 kmph "High-Speed" Railcar, No. 137 155, 1937

Pict. 13: ***"FLYING HAMBURGER"*** Diesel-electric Railcar for fast Hamburg-Berlin Intercity Service, 1934



Pict. 11b: Burlington ***"DENVER ZEPHYR"***, USA 1937

Pict. 11c: Union Pacific ***"CITY OF DENVER"***, USA, 1937



Pict. 12: Deutsche Reichsbahn articulated Diesel-electric Higher-Speed Train-Set; 1937

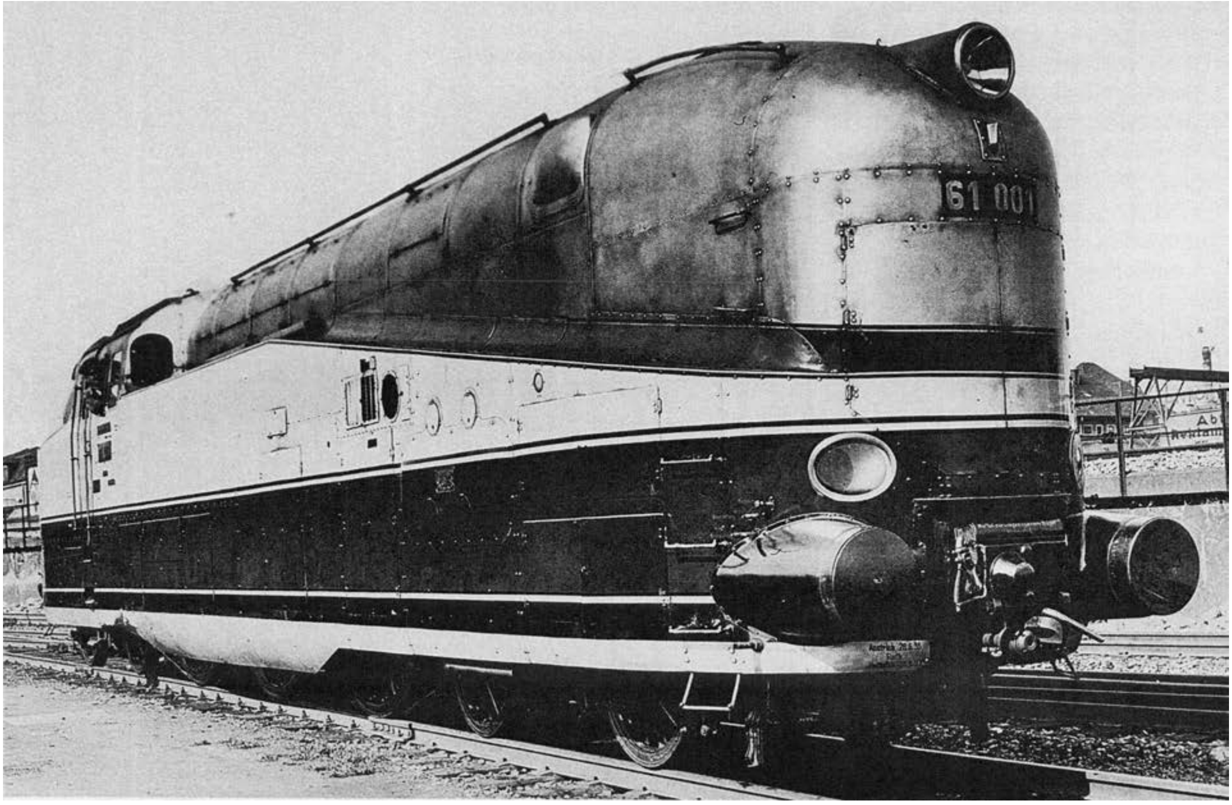
Pict. 14: Deutsche Reichsbahn articulated Diesel-electric Higher-Speed Train-Set from 1938, reconditioned 1970

Pict.: 15: Reconditioned British 2`C1` Locomotive ***"SIR NIGEL GIRESLY"*** of Type “MALLART” from 1938

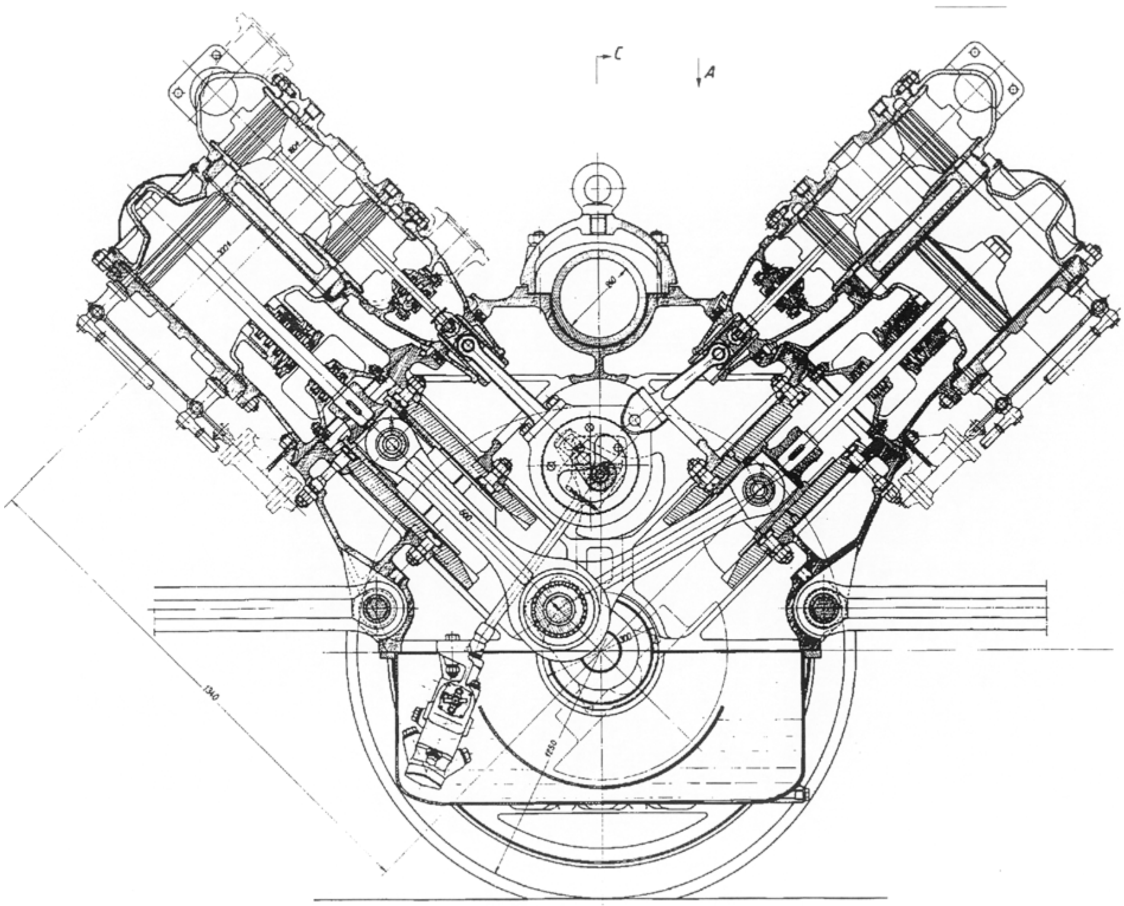
Pict. 16: German 201 kmph Steam Locomotive 2`C2`, Class 05

Pict. 17: Pennsylvania Rail Road Class S1 Steam Locomotive at the New York World's Fair of 1939

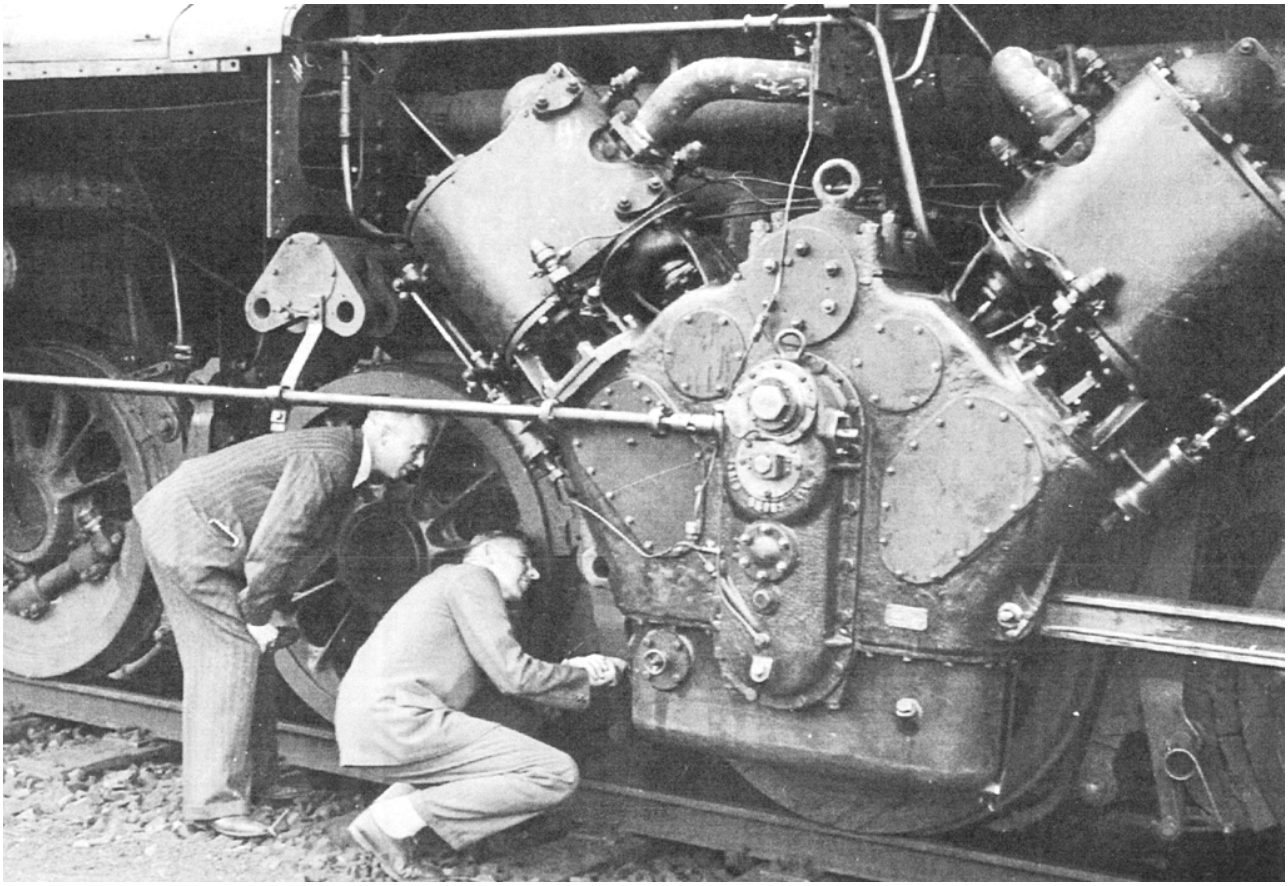
The locomotive was claimed to have exceeded 156 mph (251 km/h) on the Fort Wayne-Chicago Railroad



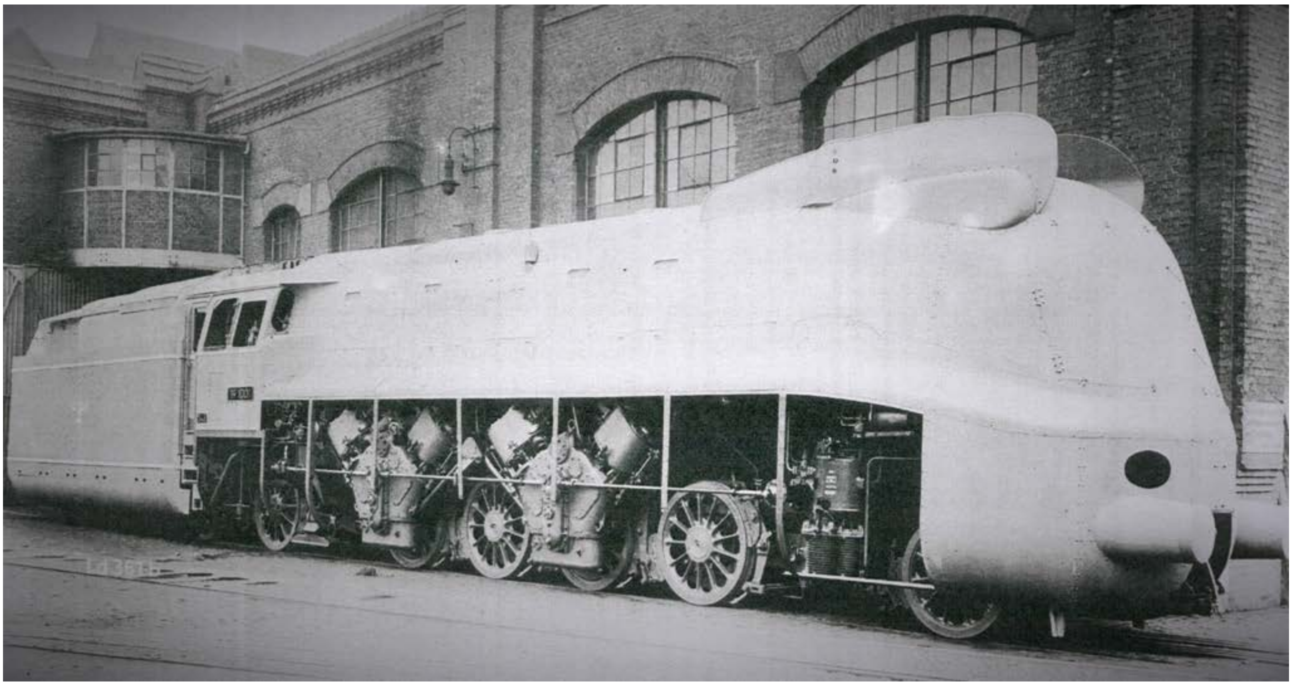
Pict. 18: German 175 kmph Steam Locomotive for Semi-High Speed Intercity Service Dresden-Berlin; 1938



Pict. 19: Steam Motor for “Higher-Speed Steam” Locomotive by Henschel; 1941



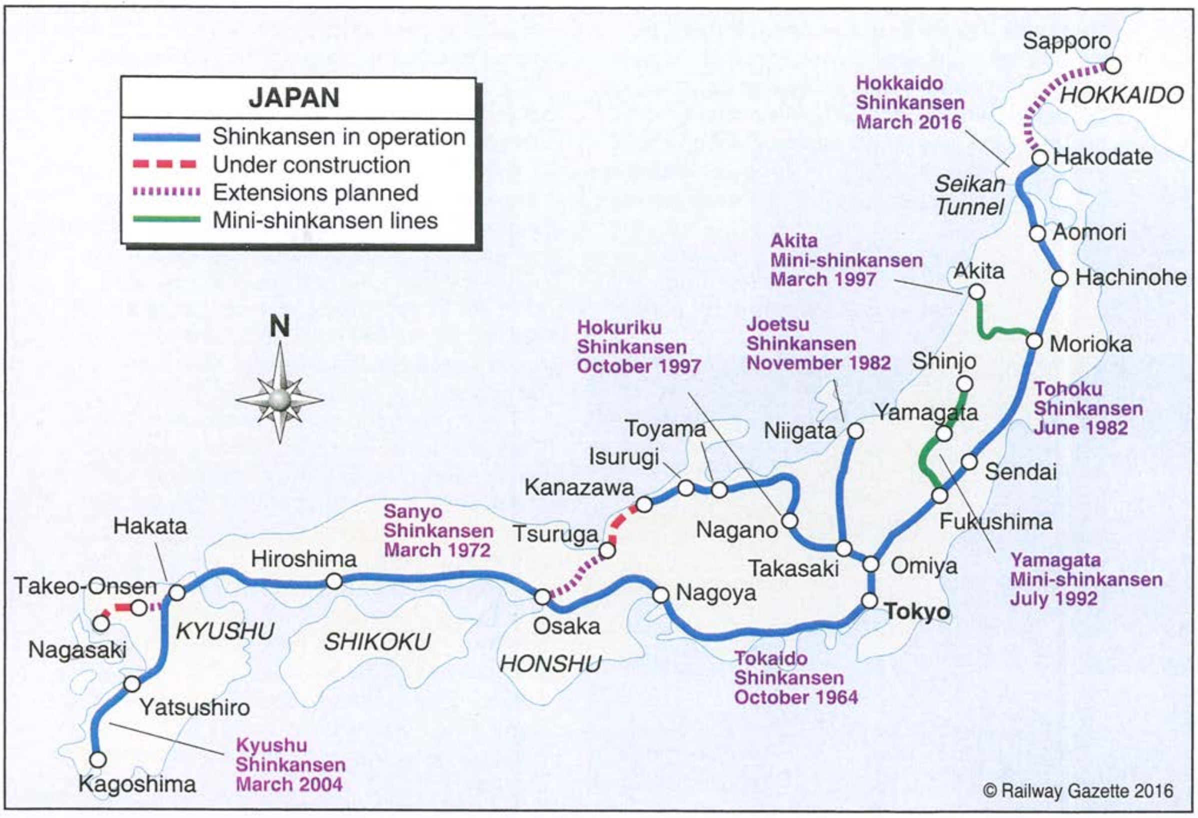
Pict. 20: Steam-Motor for German Class 19 Semi-High Speed Steam Locomotive; 1943-44



Pict. 21a: Semi-High Speed Steam-Motor Locomotive, Class 19 Germany; 1943-44

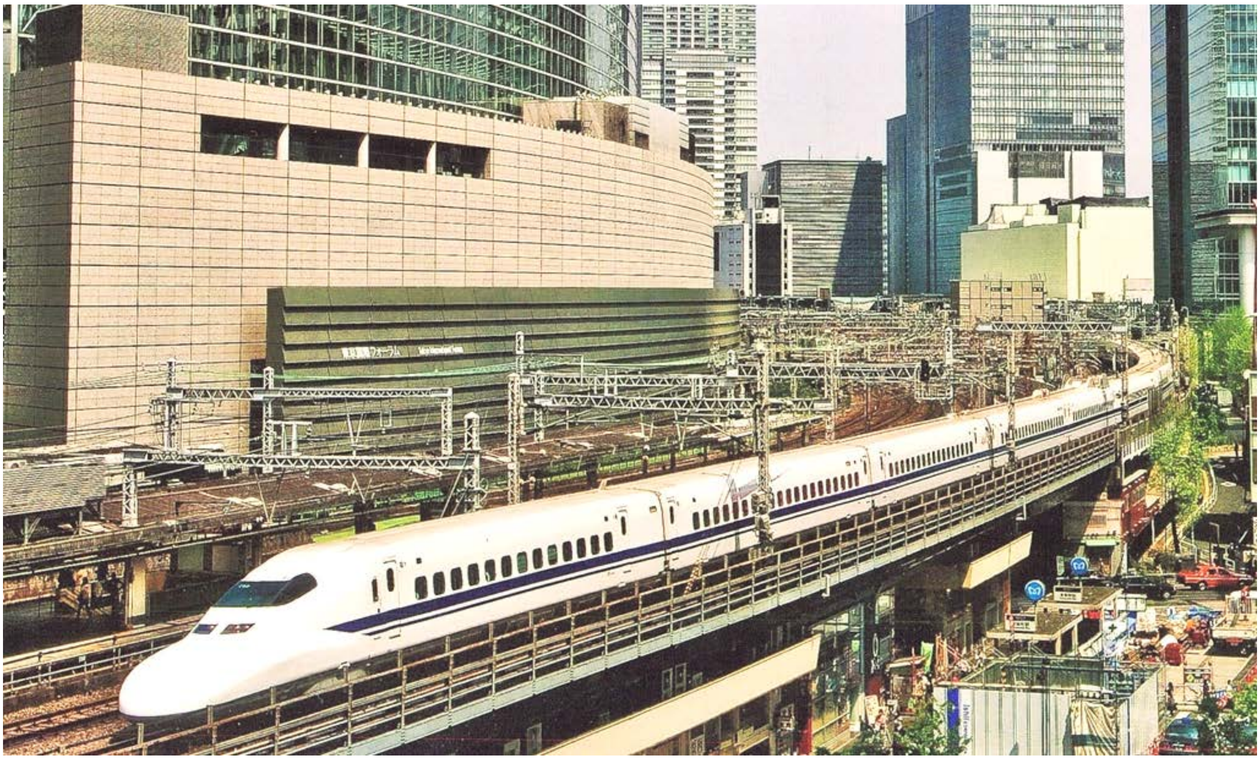
Pict. 21b: Semi-High Speed Steam-Motor Locomotive, Class 19 Germany; 1943-44

Pict. 22; China`s ambition for a strategic Route to Africa and Europe by rail from Kunming to Myanmar (under construction) with access to the Indian Ocean by sea via Sri Lanka/ Hambantota



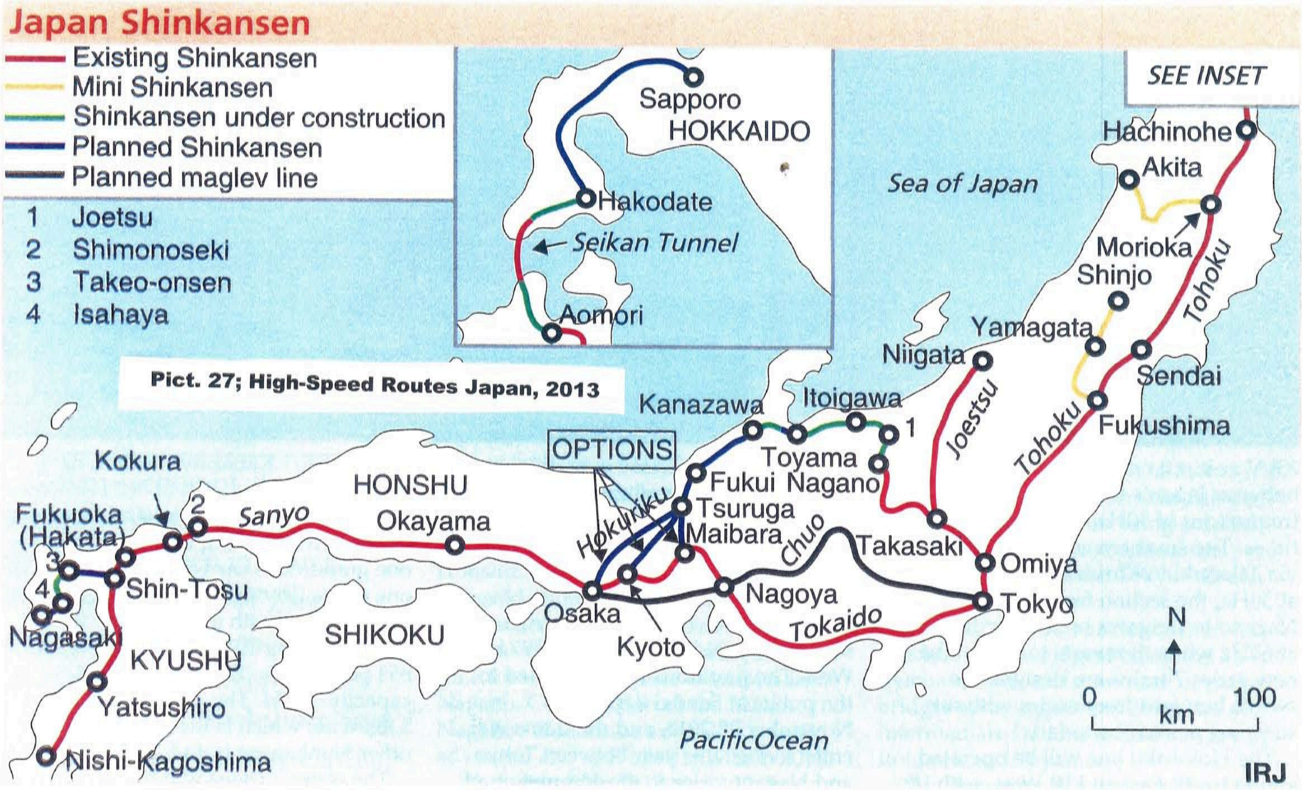
Pict. 23: Shinkansen Network in Japan, 2016

Pict. 24: Shinkansen "Bullet" Train from 1964, York Railway Museum, UK

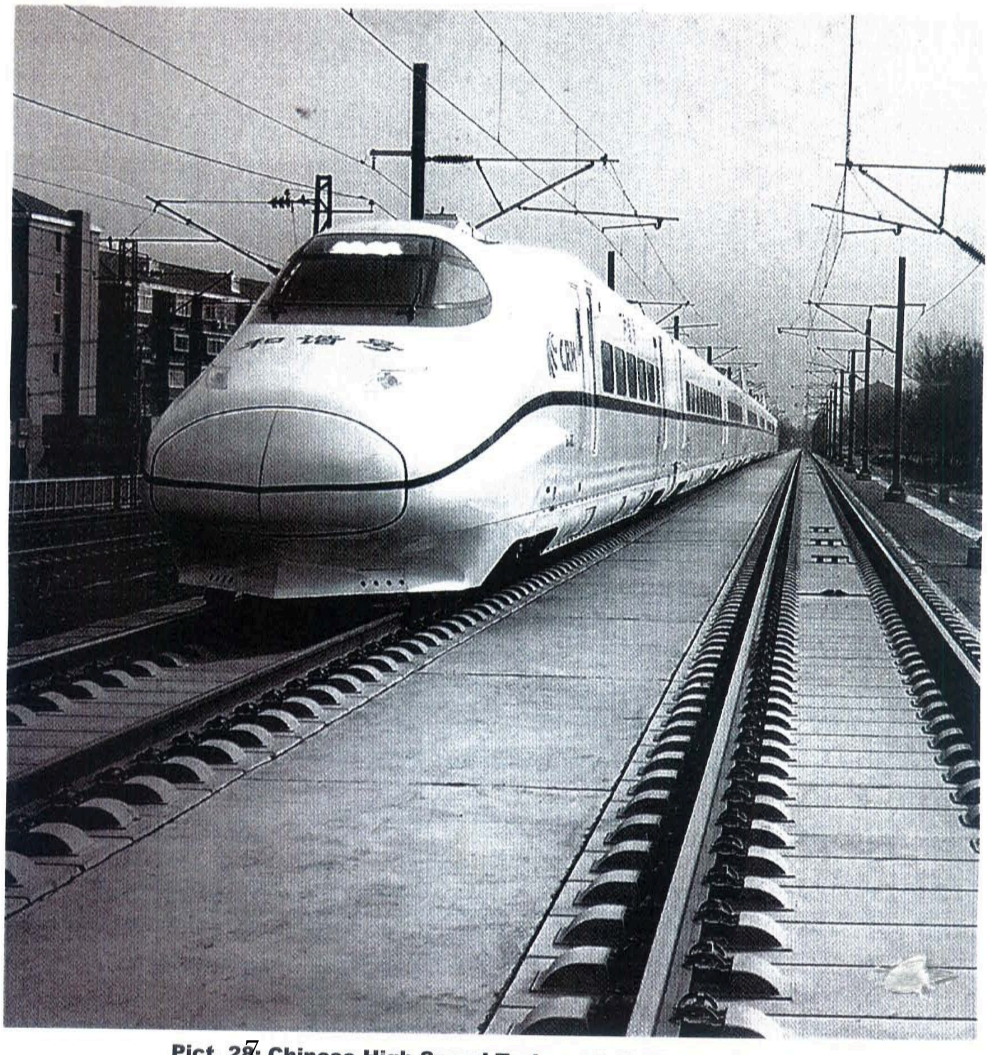


Pict. 25: Shinkansen High-Speed Train; Japan

Pict. 26: Shinkansen High-Speed Train, Japan



Pict. 27; High-Speed Routes Japan, 2013



Pict. 28: Chinese High Speed Train on Ballast-less Slab-Track

Pict. 29; "Rheda" Slab-Track before embedment in cast concrete

Pict. 30: Elevated Track for High-Speed Line in China

Pict. 31: Siemens High-Speed Train **of Type** "Velaro" **on elevated Track** in China

Pict. 32: Articulated Thalys High-Speed Trainset with Prof. Kruckenberg Jacobs Bogie Features

Pict. 33: German 330 kmph High-Speed Train ICE 3 on 1 in 25 Gradient, Cologne-Frankfurt

Pict. 35 a: 350 **to 400** kmph “Very-High-Speed**"** EMU build by CSR for the Guangzhou-Shenzhen-Hong Kong Express Link**;** 2014

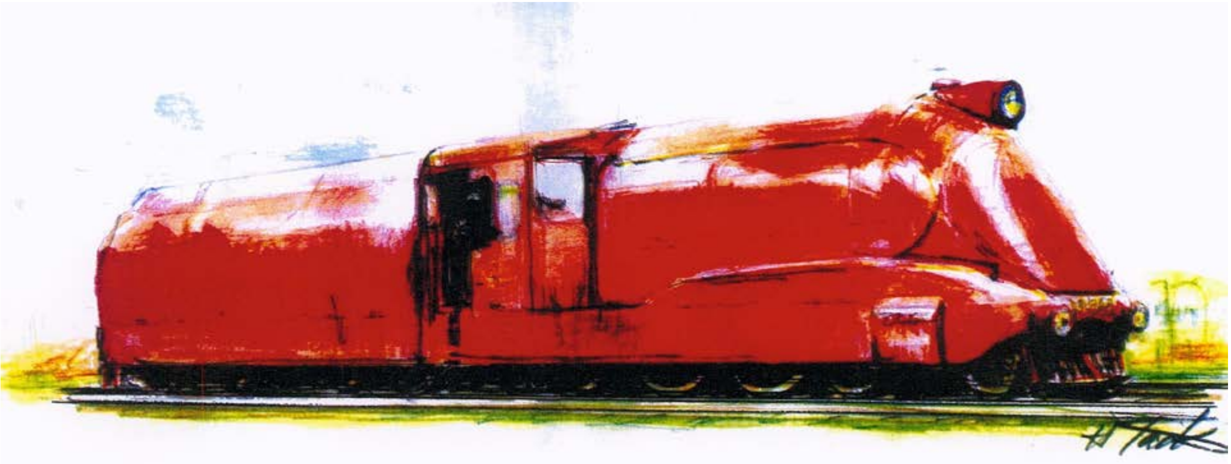
Pict. 35: 350-400 kmph Very-High-Speed Train in China**; 2015**

Pict. 36: China`s Ambition for "Very-High-Speed Rail"**; Animation by CRH, 2010**

Pict. 37: CRH 380 A, "Very-High-Speed" EMU for Beijing-Shanghai; China

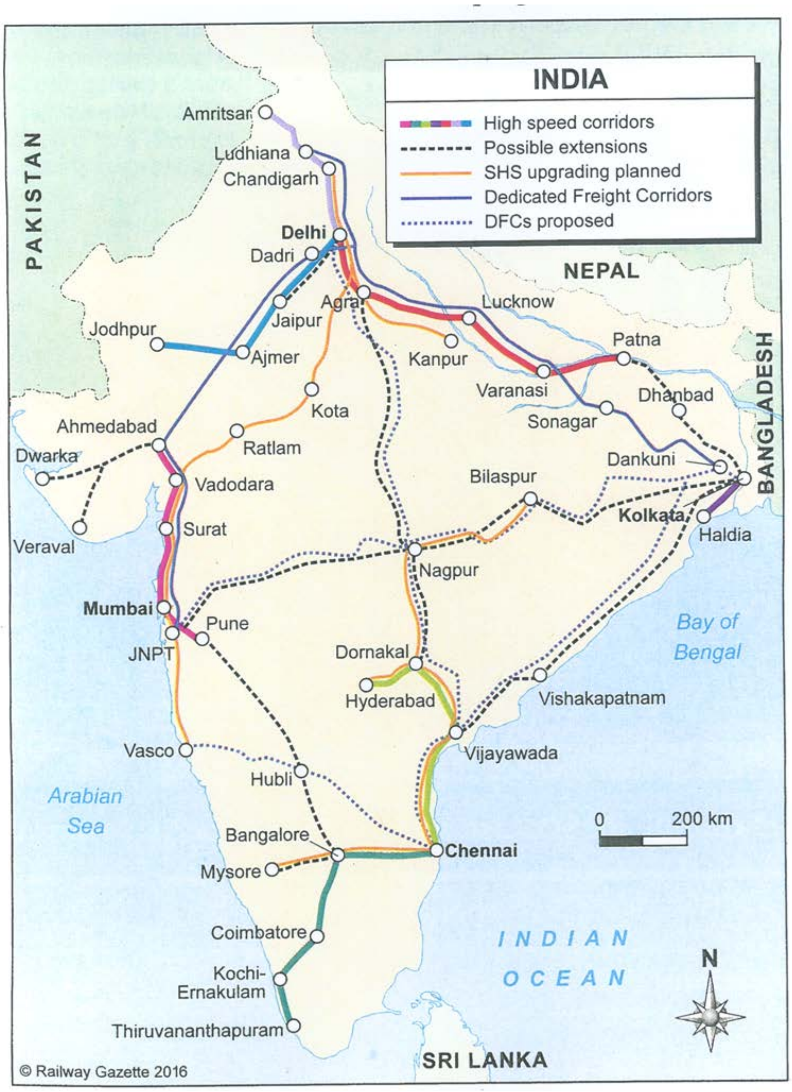
Pict. 39: "Very High-Speed", Woldrecord on Rail of 574,8 kmph by a TGV, France

Pict. 40: "Very High-Speed", 603 kmph Woldrecord by Maglev, Japan



Pict. 38: Ceylon`s Dream of a *"High-Speed"* Steam Locomotive 1936
Streamlined B1 Class Locomotive No. 242, *SIR EDWARD PAGET*.

This streamlined livery was applied in 1936 to the Oil fired Steam Locomotive No. 242, but removed 1937. Speed on Ceylon had been below that at which it comes important. This painting was prepared by Hideaki Takaura.



Pict. 39: Map of India`s ambitious Plans for Semi- and High-Speed and Dedicated Freight Routes