Locomotive modeling

(Electric Locomotives 2)

Ver 4.0 S. Tajima, February 2021

Preface

Ver1.0 of “Locomotive modeling” was edited in 2001 including 15 models by scale (mostly) 1/45. After 17 years, another 16 model locomotives are complete and I thought it was high time to revise, producing Ver2.0.

Ver2.0 is divided into three parts and “Electric Locomotive 2” is three of the three.

Class CC40110 SNCF

Modeled in 2003, Scale = 1/45

15kV, 16 2/3Hz; 25kV 50Hz; 1.5kV DC; 3kV DC
Length over buffers 14400mm.
Weight 109.6t.
Driving wheel diameter 1100mm.
Manufacturer Alsthom.

Year of construction 1964.
Width 2920 mm.
Output 4480kW.
Maximum speed 180km/h.

French design !

If you have a look again at CC14000, French engineers do enjoy their originality to some unfathomable extent.

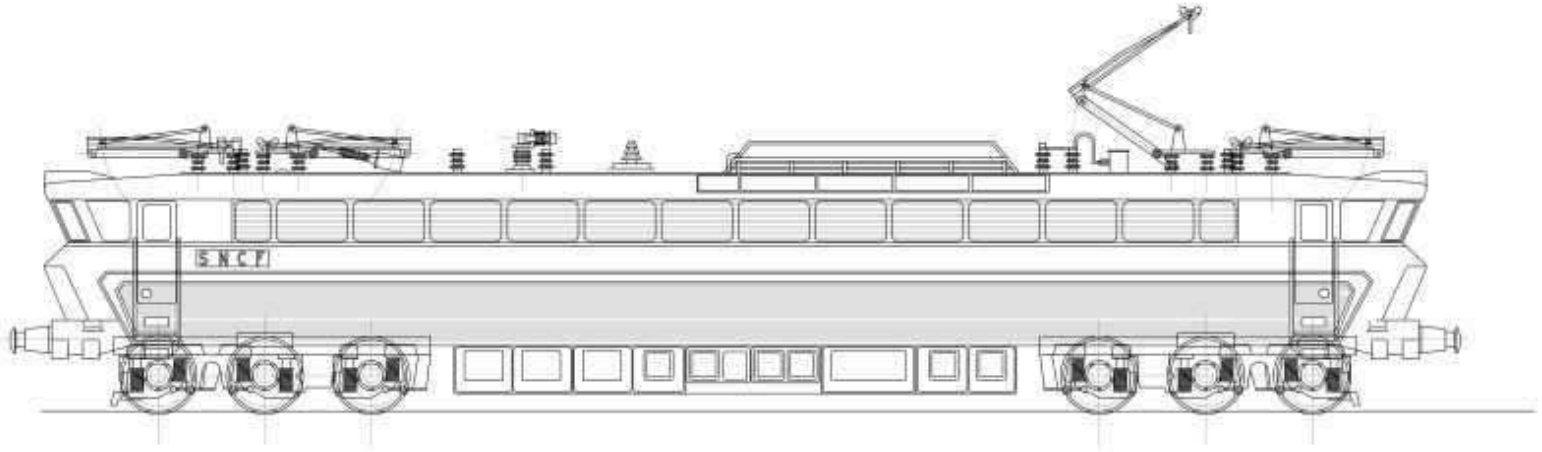
The design and ambition is very respectable, but the long body, complicated mechanism and four pantographs with relatively small output were the costs paid.

The left is a photo of the original locomotive which I took at Brussels Midi in the old days. Inversely slanted nose and window is quite unique giving strong impact when one sees this locomotive even once.

A sister locomotive ran on SNCB, thus the number of model for this class amounted to16 (6 for SNCB).

Having observed the noticeable window through the louver, the model is more or less satisfactory - if I ignored this point and compared with the original, I should have been very much chagrined.

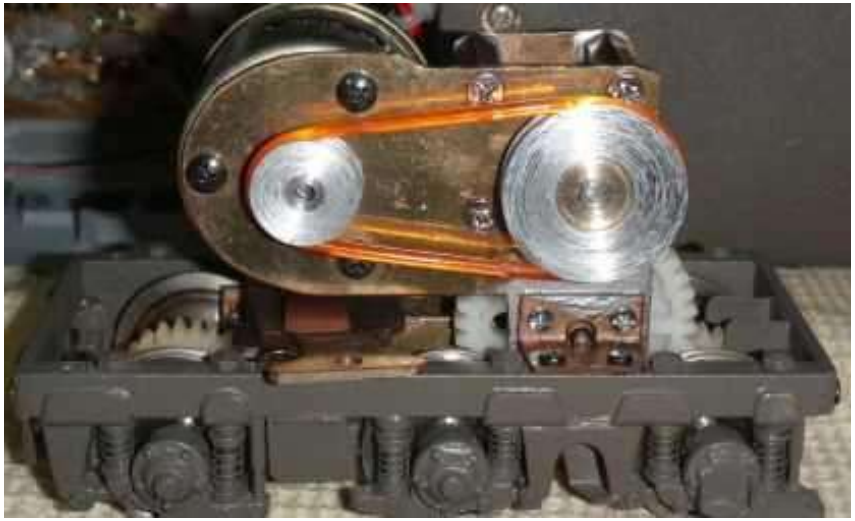
The original has a plaque at the center of the body and it was too difficult to make and has been omitted until today, and may be for good.



As a model, body and number of pantographs are the essential points. Although it is not very clear, pantographs are not identical and needed to make slightly different ways. Body has distinct corrugation with long louver for ventilation. In this model, the louver is made of acrylic and underneath the louver, windows are opened. Louver is painted wine red, but the inside windows are discernible by black shadow caused by dust (in the case of original) which is actually painted black from inside for the model.

There used to be side windows open, but were covered by later modification. Drivers didn't like it perhaps.

The driving mechanism of the model tried to follow the original to some extent - single motor per bogie and gear train power transmission.



The locomotive has a single motor per bogie and the power is delivered to all driving wheels via gear train which is the reason of short wheel base of the bogie. And this locomotive is designed to cover most of the European voltage systems - although that does not imply most of the railways, because there still remains the difference of the signaling system.

References ;

Pascal Dumont Les Locomotives Polycourant de l'artere Paris - Bruxelles , Volume 1 and 2, Les Editions du Cabri.

Jean-Pierre Schenkel Locomotive Electriques, Max Delie, 1988

25kV, 50Hz
Year of construction 1963.
Length over buffers 20000mm.
Width 3030 mm.
Weight 126t.
Output 4920kW.
Driving wheel diameter 1250mm.
Maximum speed 120km/h.
Manufacturer Skoda.

Sole information of this model is obtained via Internet. The original model has been a single prototype and never put to mass production; but the Bo-Bo version of this locomotive called class 240 were mass produced and well known by it's distinctive front design. The original locomotive was designed by a professional industrial designer and most singular compared with a series of locomotives produced by Czech farm Skoda.

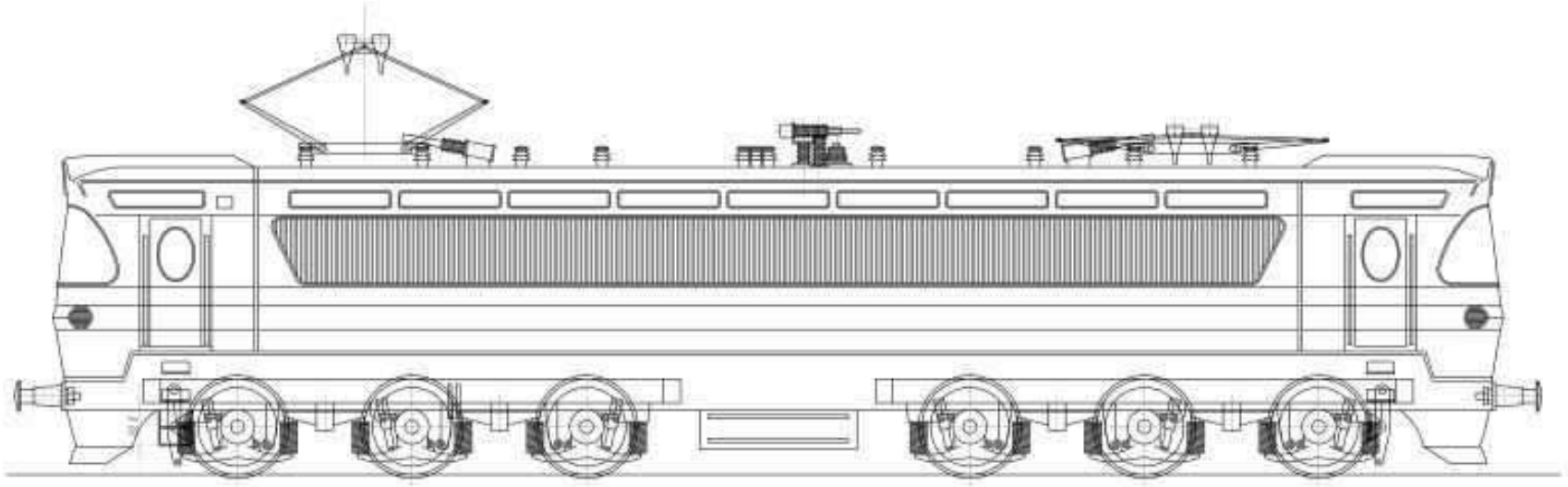
Sister locomotives seemed to have been derived from this one for export (to Soviet Union), but the looks were so degraded. Not only the design, but the color scheme completely surpassed the other locomotives run on CD. Singularity of this model is well recognized that no locomotives were designed by Skoda with distinction until quite recently.

It has been in a forlorn condition for a long period, but now in display at the technical museum in Pilzen.

Wide and curved front/rear windows, curved monitor windows (windows over the ventilator grille) ,oval door window, finish of the ventilator ends and white band were obviously what the designer had in his mind.

The luckiest - or motive triggering point was that the rough drawing was found on the Internet. Drawings, pictures with some technical data were enough to start scratch building a new model.

One of the things that has been troubling me while making the model was the purpose of the tear dropped slit on the front ends. However, at one time, I had a chance to see a picture (of during construction ?) that showed it was a housing of a whistle.

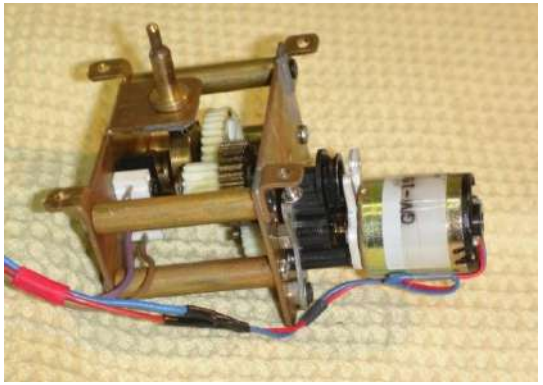


The layouts of roof equipments are not quite clear.

And orange/yellow livery is prone to get dirtier. Should have been the same problem to the original one.

The class 240 has different liveries in these days on CD railroad, but none can surpass the original. This generally happens for any locomotives.

The most cumbersome part in constructing this locomotive may have been the making of driving wheels. The model has 12 axes - 24 wheels with spokes. The wheels are turned by a lathe as blank disks with flange, then spokes are scribed on the blank. After having drilled appropriate holes, most laborious work of sculpturing by hand piece grinder follows. Finish is nickel plating resulting a sample like above.



Since pantographs are controlled remotely, they require drivers and one such example are shown on the left.

The driver has a small gear reduced motor which drives another gears to obtain appropriate speed. The lever is driven by an eccentric cam and lift the pantograph up or down. The position of pantograph is sensed by a micro switch.

References

http://www.parostroj.net/vozidla/S699/S699.htm
https://de.wikipedia.org/wiki/%C4%8CSD_S_699.001

Class 350 by CD (Czech Railway)

Modeled in 2006, Scale = 1/45

25kV, 50Hz ; 3kVDC
Year of construction 1976.
Length over buffers 16740mm.
Width 2940 mm.
Weight 189.6t.
Output 4200kW.
Driving wheel diameter 1250mm.
Maximum speed 160km/h.
Manufacturer Skoda.

This is one of the most colorful locomotives run on the Czech railways, although there are many variations as of 2018. The design does not look like something notable, but the philosophy of (body) design is very much apart form that of S699. One can only imagine what happened ten years after the class 240 - the design of class 350 is obviously mechanical necessity driven.

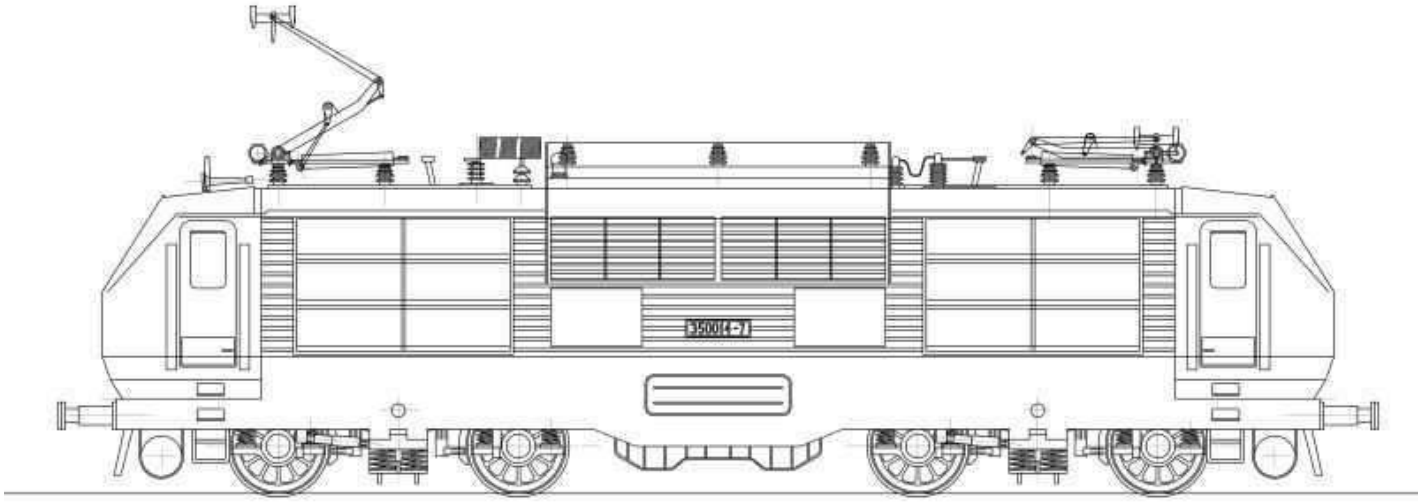
Corrugated body, wide area of ventilation, just cut out slanted front end and protruding head light hastily attached before it's forgotten. However, all those industrial design-less construction is completely paid off by it's color scheme.

Skoda seems to have abandoned industrial design after S699 and class 240 for almost half a century and continuously produced engineer thought up locomotives - CD class 380 in 2008 clearly has industrial designers' work.

Perhaps the most significant aspects of this class is the total asymmetrical design on both sides.

As seen here, one side has a big air outlet upon the roof only, whereas the other side has air intake that corresponds to the other side and wide ventilation grilles near both ends.

Although the body is compact, the requirement of those wide ventilation capabilities may imply that the locomotive did not have very good efficiency - it has something that must be heavily cooled off.

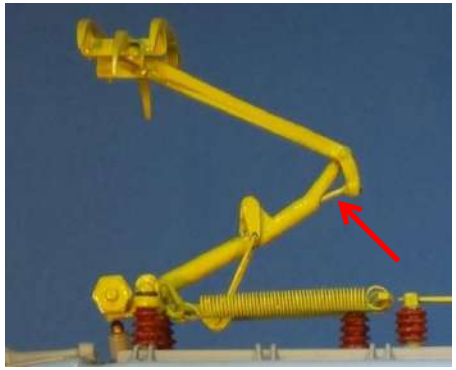


Center ventilation air intake, presumably for transformer which is just visible under the center of body.

Also, two wide ventilation grilles are provided for motors, I believe.

Air tanks are hung undernieth the driver's cab.

Another point of interest is in the design of pantographs. Structure of the pantograph is so called single arm type, but the arm to control the shape in up position goes through the main lower shaft.



This looks like totally unnecessary complication and presented a challenge in modeling - the result is shown above.

Left is a picture of a pantograph equipped on SNCB class20 whose arm structure is much simpler and this type is most common.

References

https://de.wikipedia.org/wiki/%C4%8CSD-Baureihe_ES_499.0

Ae 3/6 I 10711 by SBB

Modeled in 2007, Scale = 1/45

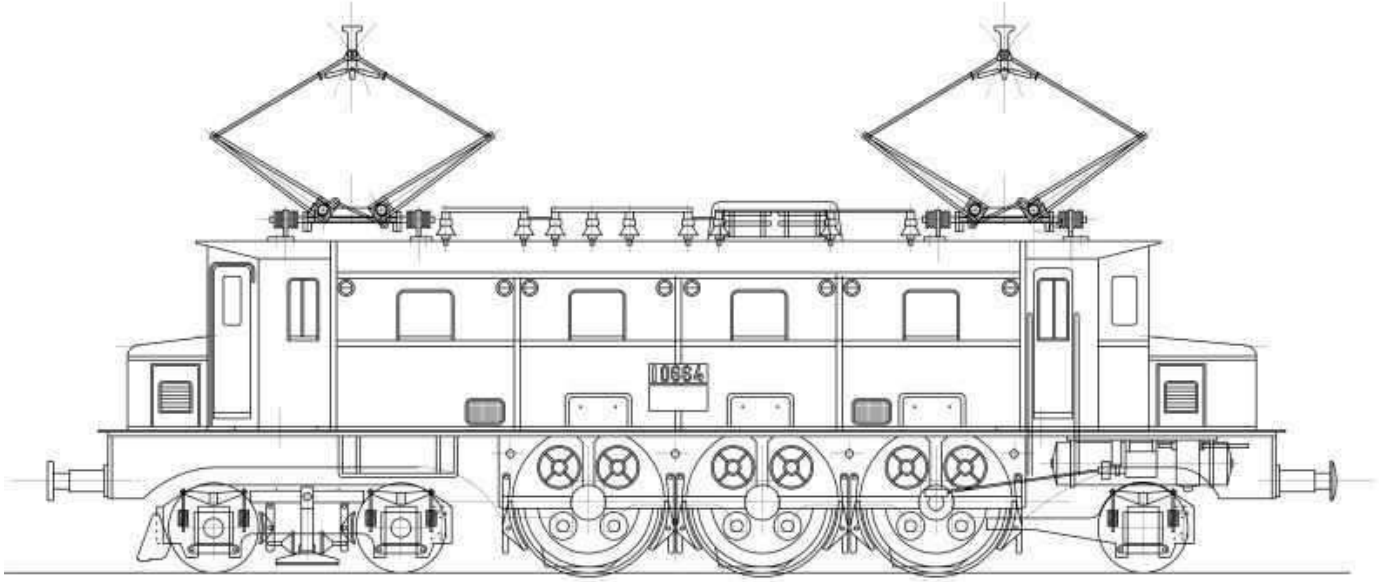
15kV, 16 2/3Hz
Length over buffers 14760mm.
Output 1600kW.
Maximum speed 110km/h.

Year of construction 1927.
Weight 93t.
Driving wheel diameter 1610mm.
Manufacturer SLM.

This locomotive is very famous with it's driving mechanism called Buchli drive. Body mounted motors drive big spur gear coupled flexibly on the outer side of the driving wheel. This flexible coupling is called Buchli system named after the inventor. Though the precise principle how it works is hardly understood, it has worked successfully for a long time and proved to be reliable.

The picture above shows the Buchli driver side, the pinion and spur gears are completely encased. As observable by the picture below, gear is supported by axle box with heavy beams and some monitoring caps are provided.

Since the other side is not driven, the spoked driving wheels are observable inside the piping for cooling oil. (Some Buchli drive locomotives are driven both side - in this case, the driving wheels are completely unobservable.)



The elevation showing the Buchli driver side. Resistors seem to be mounted on the roof with cover which I could not make properly. Below shows the other side. Completely asymmetric which is one of the characters of classic Swiss locomotives.

The model tried to simulate the original design. As seen above, three pinion gears are driving each driving wheel on which big gears are “fixed” - unable to realize the original Buchli system.

References

Werner Nef Buchli-Oldtimer der Schweiz, GeraMond, 2003

Herausgegeben vom Generalsekretariat SBB SBB Lokomotiven und Triebwagen, 1995

SNCB Type 20 (2019)

Modeled in 2008, Scale = 1/45

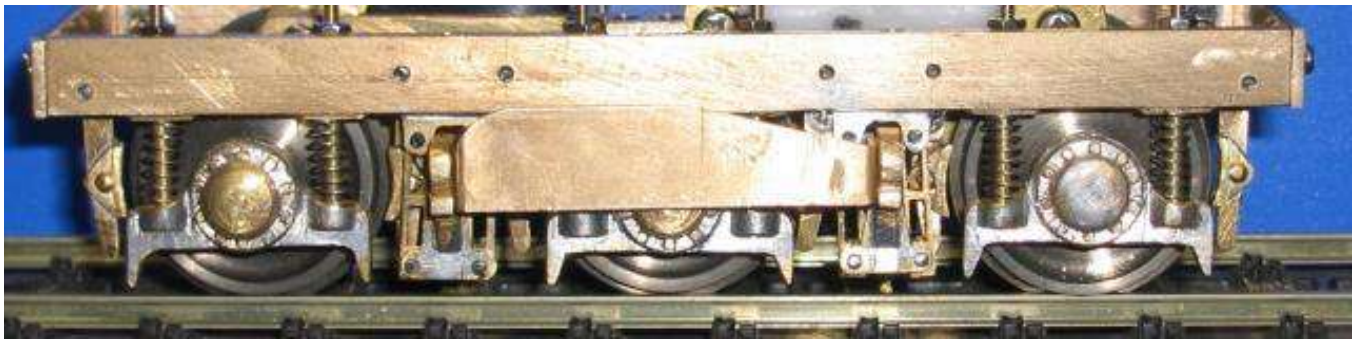
3kV DC
Length over buffers 19504mm.
Output 5150kW.
Maximum speed 160km/h.

Year of construction 1975.
Weight 111t.
Driving wheel diameter 1250mm.
Manufacturer ACEC.

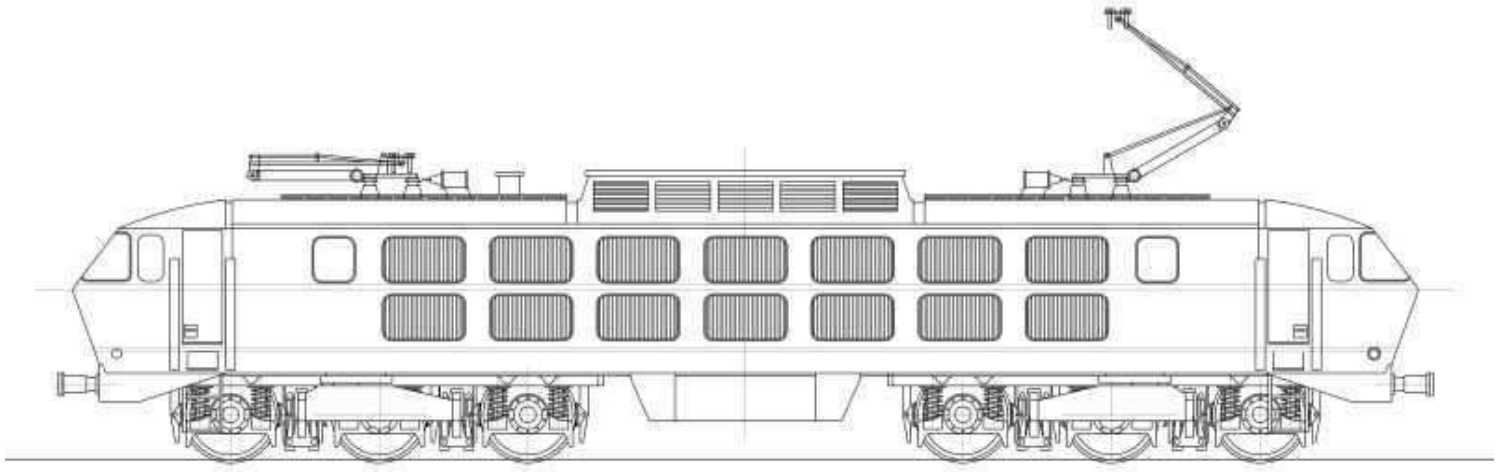
Something is written on this component

This is one of the locomotives that has been on my waiting list for a long time. The above picture was taken in Brussels Midi in 1998 whose distinctive bogie is focused. Because of the part of the bogie, the structure of the 3 axle bogie was hard to imagine. That was the reason that I was unable to model this one until 2008 waiting for ten years. Although the pictures of this locomotives are available by the Internet, the structure of the bogie is unknown until I learned that the suspension is derived from Swiss Ae-6/6.

Once understood the structure of the bogie, I did start scratch building, although some engraved characters on the bogie were unable to reproduce due to two factors - firstly, what is written is unable to observe and secondly, even if characters are known I have no means to engrave. But still, this is a point of chagrin to me.



The shape of the end of the body seems to be identical with that of class 27, except corner windows of class 20. Because of the arrangement of the driving wheel (Co-Co), the silhouette looks very slender. So many ventilation grills suggest that the locomotive has rheostatic control, but in fact it is controlled by thyristor.



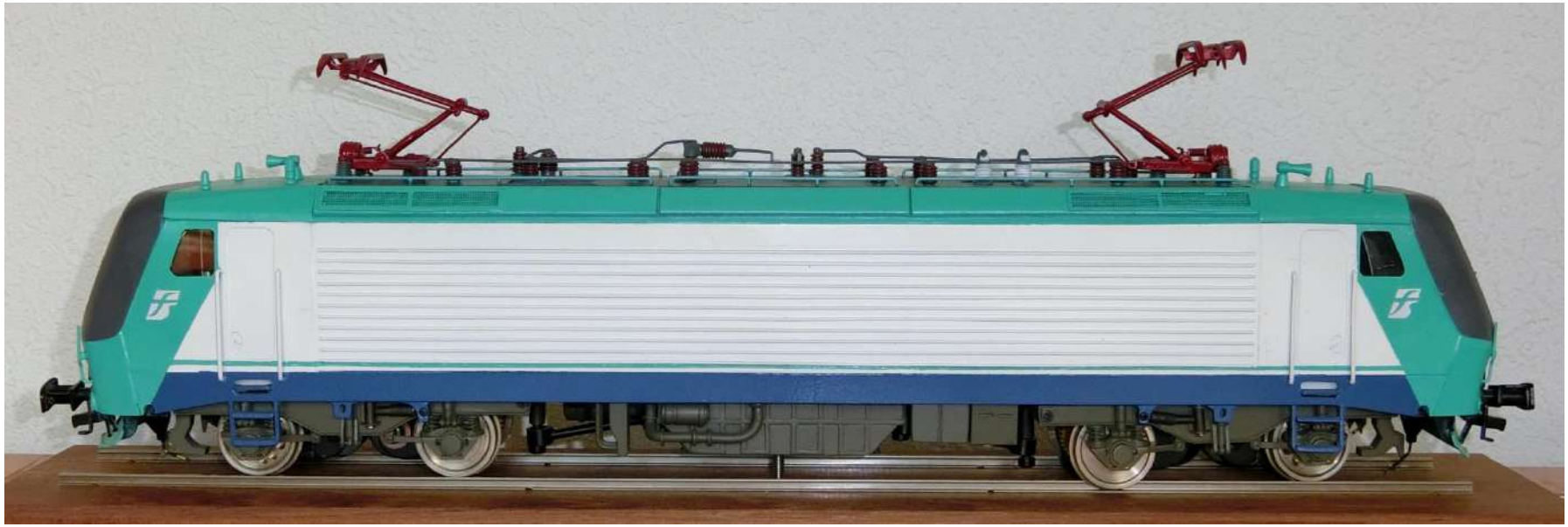
References

Hans-Bernhard Schonborn Gotthardlok Ae-6/6, GeraMond, 2001

Max Delie, Jean-Pierre Schenkel. Elektrishe Lokomotiven. G.Blanchart & Cie, Brussel. 1988.

FS Class E.412

Modeled in 2009, Scale = 1/45



Modern locomotive to cover countries Italy, Switzerland, Austria and Germany. It is driven by three-phase asynchronous motor - squirrel cage induction motor. Thus the power from catenary is converted to variable frequency, variable voltage alternating current with conversion loss only. This is the reason that there are very small air exchange with outside.

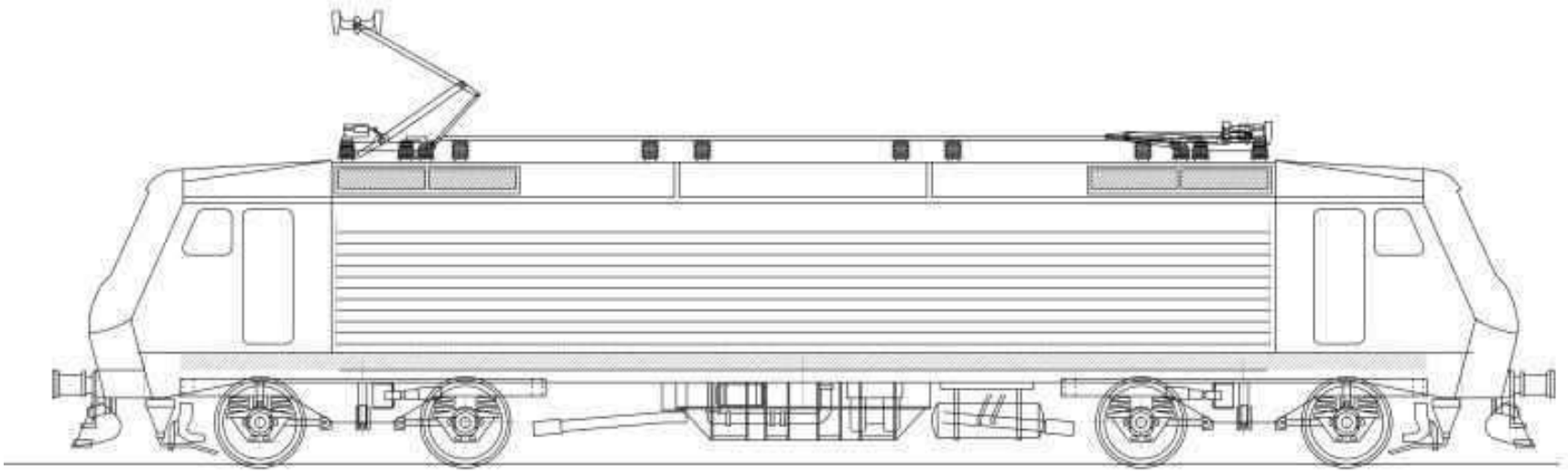
The high maximum speed with small diameter driving wheels implies that high speed small motors are used driven by the current semiconductor technology.

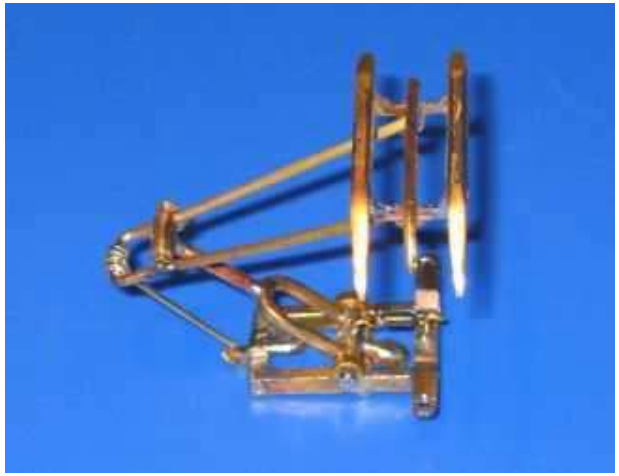
15kV, 16 2/3Hz , 1.5kVDC, 3kVDC
Length over buffers 19400mm.
Weight 88.7t.
Driving wheel diameter 1100mm.
Manufacturer Adtranz, Bombardier.

Year of construction 1996.
Width 2085 mm.
Output 6000kW(3kV), 5500kW(15kV AC), 2700kW(1.5kV).
Maximum speed 220km/h.

Color scheme is beautiful, matching with the industrially designed body line. Particularly if we compare with the livery of class E645, the change of generation is obvious. (However, E645 has 6 driving wheels which results better adhesion, and is still competitive in mountainous area.)

Inside of the model showing driving bogies and controller.





Shape of the bogie truck is not quite correct in the diagram above, although mostly unobservable.

Pantograph is relatively simple structured, but connection of the U shape and T bar is bit cumbersome.
Later, this is painted red.

Italian locomotives have their own charm - some older models with awful, forbidden attractiveness that you can't stop gazing, whereas the modern ones express clear designers' intention reminding that of the Czech S699. Using corrugated steel to the body generally results dark gloomy image found on Soviet's locomotives, but here the white color makes the corrugation into a symbol of light and speed. But the livery for PKP (Polish state railways) model which is identical in design, has red face instead of dark grey, the result is disastrous.

References

https://en.wikipedia.org/wiki/FS_Class_E.412
https://www.railcolor.net/index.php?nav=1406595&lang=1

Class EP-2, “Bipolar” The Milwaukee Road

Modeled in 2009 - 2010, Scale = 1/45

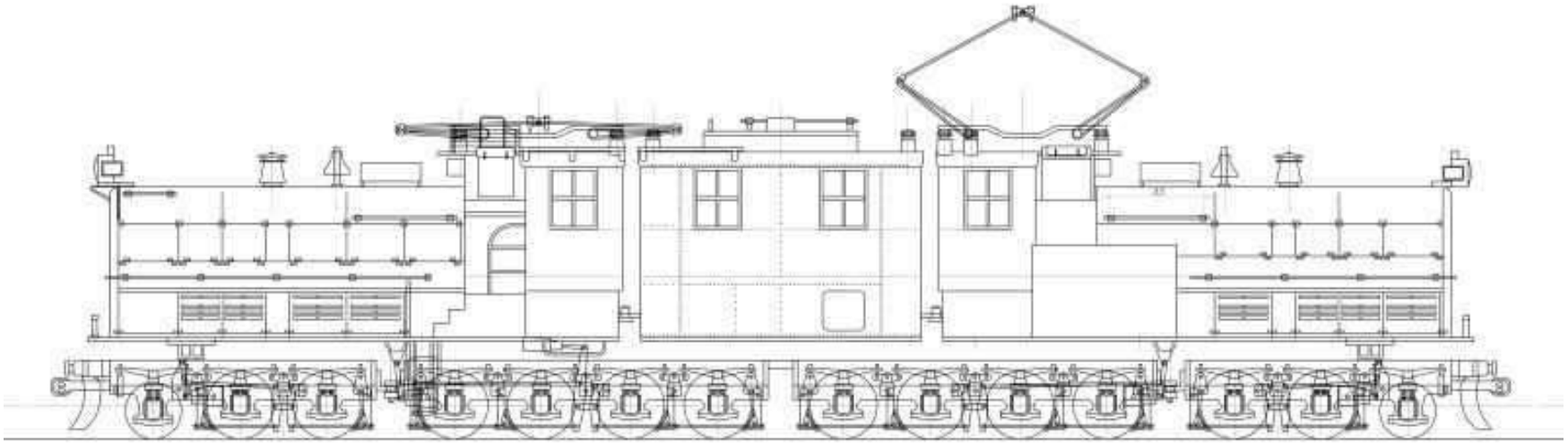
3kV DC.
Length over buffers 23160mm.
Output 3311kW.
Maximum speed 113km/h.

Year of construction 1919.
Weight 240t.
Driving wheel diameter 1117mm.
Manufacturer General Electric.

American simplicity and brute force design. “Bipolar” refers to the driving motor structure. The armature and driving wheel are constructed as a single component and the vertical movement of the wheel/armature relative to the chassis mounted stator is solved by making the stator with only two field poles. By this idea, the output and efficiency of the motor are surely limited. Thus, even with a merit of no maintenance for gears, the axles required were TWELVE, much exceeding the number of wheels of the conventional electric locomotives. Besides, for every tire wear, wheels with armature are coped with.

That is one of the reasons why this locomotive have huge three piece body - center piece seems to house steam boiler for passenger car warming - though, the reason of the bonnet style body is unknown to me. Visibility? Then, why not cab forward design ?

Having criticized as above, the author feels the venturous spirit of the designer (and railway company). May be fundamental idea of the system surpassed anything else and left us as an amazing experiment. And this was designed in 1919! Served for forty long yeas as well.

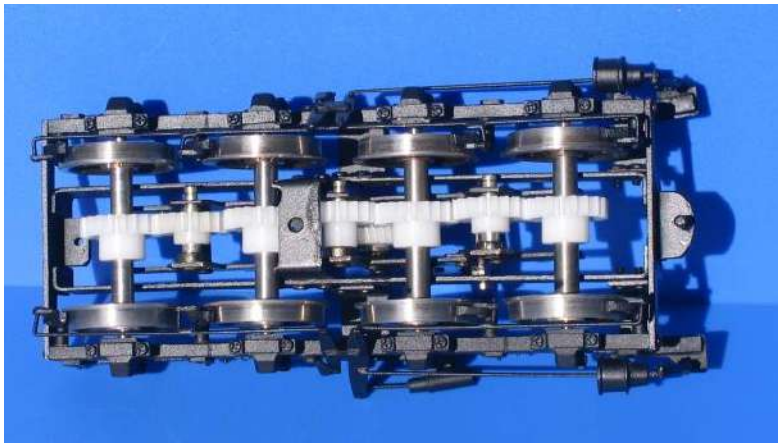


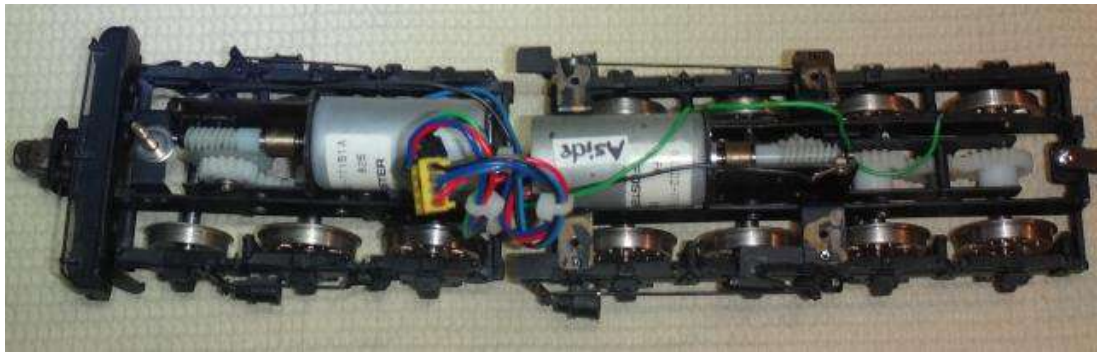
Observing the elevation above makes one daunted in trying to make a model. Count the number of wheels to produce, most of which are spoked driving wheels!

What I still don't know is the somewhat ventilator like components mounted in front of bells. At the head of the cab door are the sandboxes. It is clear that six wires (tubes) are running downwards.

On top of the center body, a chimney is observable.

On modeling, I tried to keep the American spirits by driving all the driving wheels by mounting four motors, one for each set of tracks, and the driving wheels are coupled together by gear train.





Another challenging factor was the number of spoked wheels to be made. It has 24 driving wheel discs and 4 leading wheel disks totaling 28 discs to be manually made, if my count is correct. (well over three Bo-Bo locomotives ; another American way.)

References

https://en.wikipedia.org/wiki/Milwaukee_Road_class_EP-2

Brian Hollingthworth, The great book of Trains, Salamander books 1987.

DRG Class E70 (Bavarian EG 2 × 2/2)

Modeled in 2011, Scale = 1/45

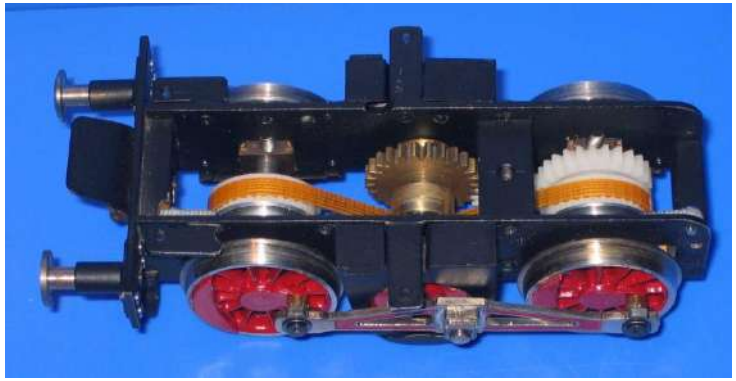
If compared with the “Bipolar”, the difference of scale would give quite an impression. Both of them are constructed almost in the same year.

15kV, 16 2/3Hz
Length over buffers 12540mm.
Output 720kW.
Maximum speed 50km/h.

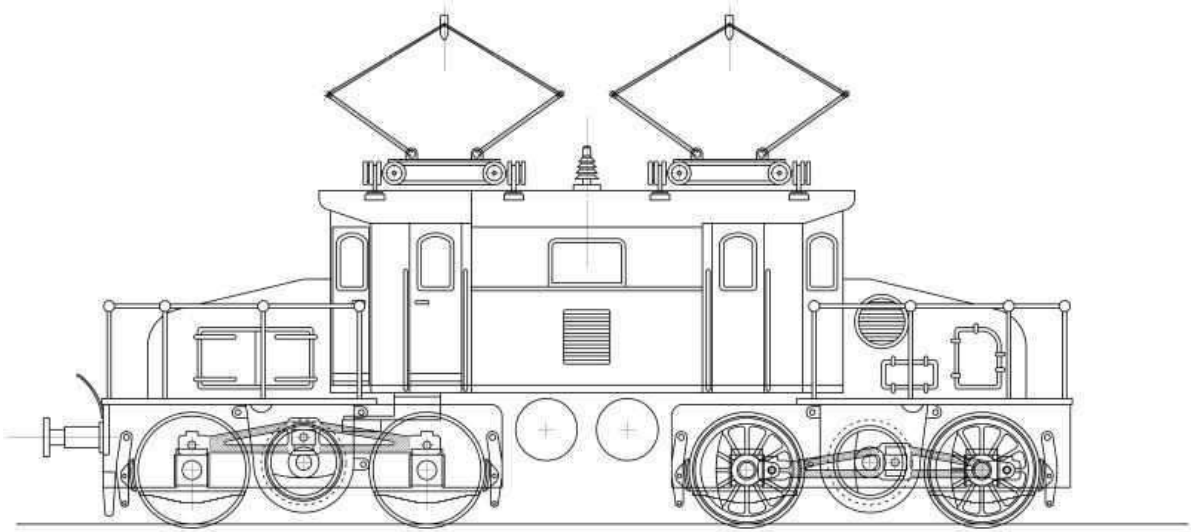
Year of construction 1920.
Weight 64.8t.
Driving wheel diameter 1250mm.
Manufacturer Kraus, BBC.

Originally built for Bavarian railways (Bayerische EG 2 × 2/2) for the electrification between Salzburg - Berchtesgaden. Only two were built and later renumbered E7021 and E7022. Each bogie has a single motor which drives a disc, and the disc is coupled with two driving wheels by a triangular rod.

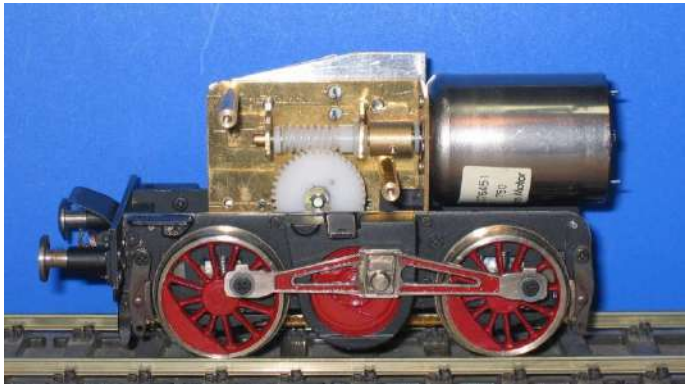
Both E70 locomotives were withdrawn in1950/51, but the compact locomotive with rod motion makes a good locomotive model, thus still in circulation in modeling world.

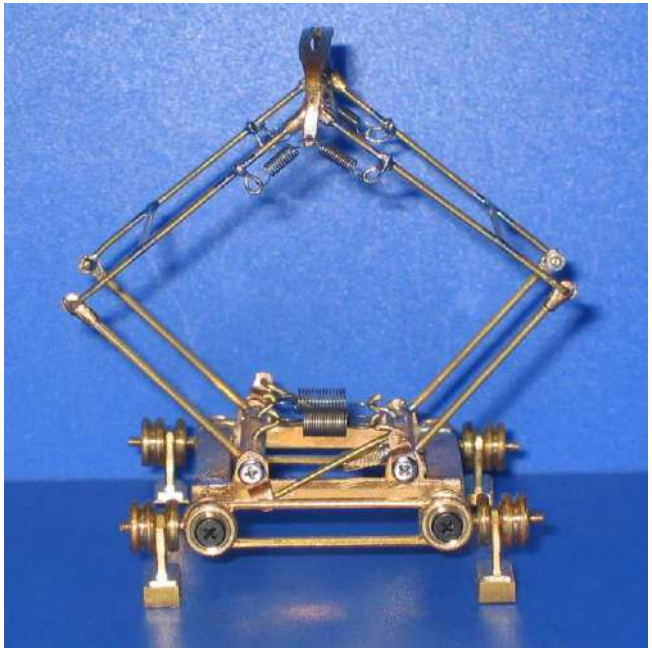


Driving bogie with coupling rod.
Both driving wheels are connected by a timing belt inside, and the rod actually is a dummy.



Driving bogie with coupling rod.
Both driving wheels are connected by a timing belt inside, and the rod actually is a dummy.





Since this locomotive is very compact, the inside of the body is full with components - two motors, control circuit and two pantograph drivers.

Pantographs are conventional diamond, but the base is fairly complicated requiring careful design, preparation and assembly.

References

Baezold, Fiebig Elektrische Lokomotiven deutcher Eisenbahnen, Alba publikation, 1984
https://de.wikipedia.org/wiki/Bayerische_EG_2

DB Class 111,

Modeled in 2011, Scale = 1/45

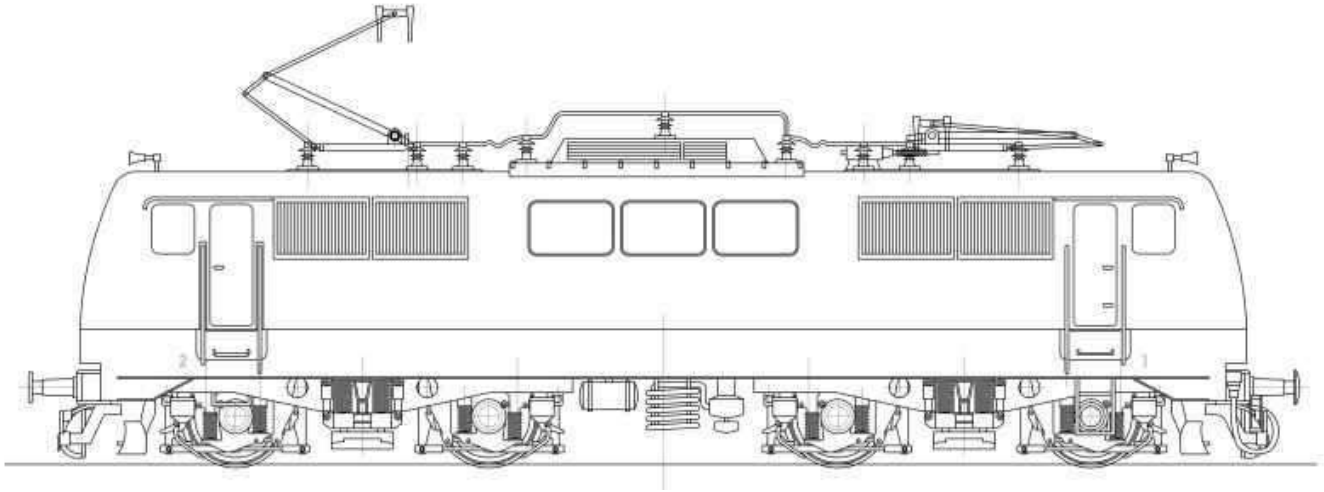
15kV, 16 2/3Hz
Length over buffers 16750mm.
Weight 83t.
Driving wheel diameter 1250mm.
Manufacturer Krauss-Maffei, Henschel, Krupp, AEG, BBC.

Year of construction 1974-1984.
Width 3000mm.
Output 3720kW.
Maximum speed 160km/h.

Class 111 is produced to cope with the increasing traffic on Germany after the war. The traction motor is AC commutator type under 16.2/3 Hz and this class may be considered to be the last of the conventional system. Total of 227 units were produced and still in service as of 2018.

Compact and well balanced design were clearly recognized while modeling - balanced size of bogie and wheels, arrangement of pantographs and ventilation windows. All the components are structured as they should be. An interesting feature(?) is that a part of the internal equipments are observable through the center clear windows.

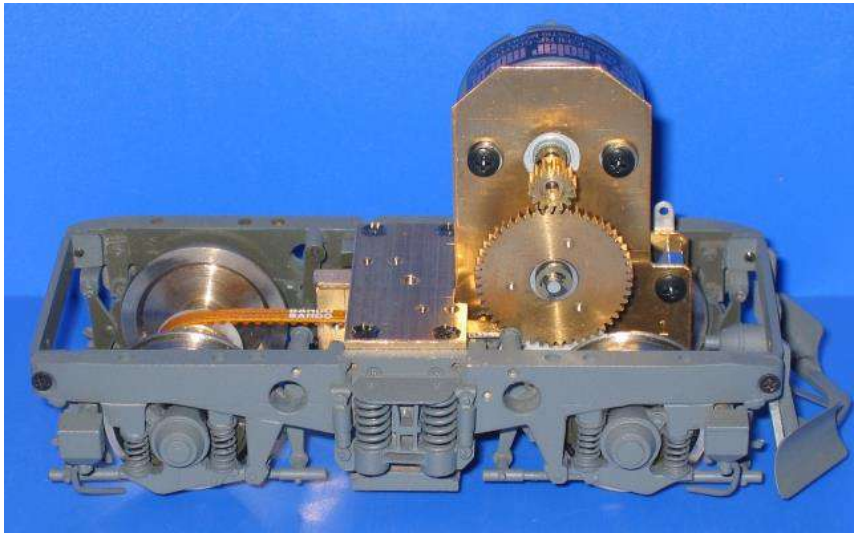
As of modeling, color scheme is difficult. In this livery, the lower side blue is finished by painting transparent yellow over standard blue.



One of the difficulties was the cavity like step just above the first driving wheel.

Also, the line of the chassis and body is intentionally made to reproduce the original locomotive's image.

Inside the transparent windows, some internal equipments are observable. Since it was not quite clear what they were, they just simulate images only.



Driving wheel is equipped with brake component which is not observable when assembled into a bogie.

Controller installed inside the body. Dummy internal equipments are modeled so that these electronic components are not observed through the window. Big power transistor at the center is a series regulator for the motor - over specification, I only used this one since it was there.

References

Baezold, Fiebig Elektrische Lokomotiven deutcher Eisenbahnen, Alba publikation, 1984
J. Michael Mehltretter Elektrische Triebfahrzeuge Motor buch verlag 1986

BLS Be-5/7

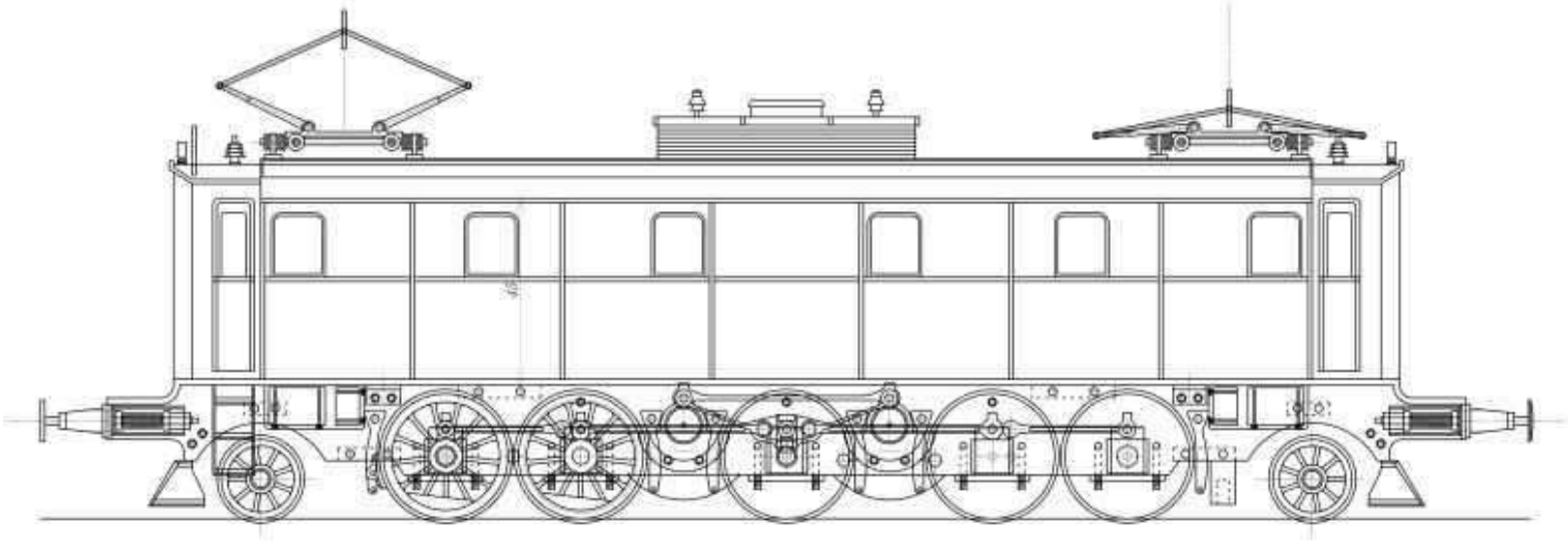
Modeled in 2013-14, Scale = 1/45

15kV, 16 2/3Hz
Length over buffers 16000mm.
Output 1840kW.
Maximum speed 75km/h.

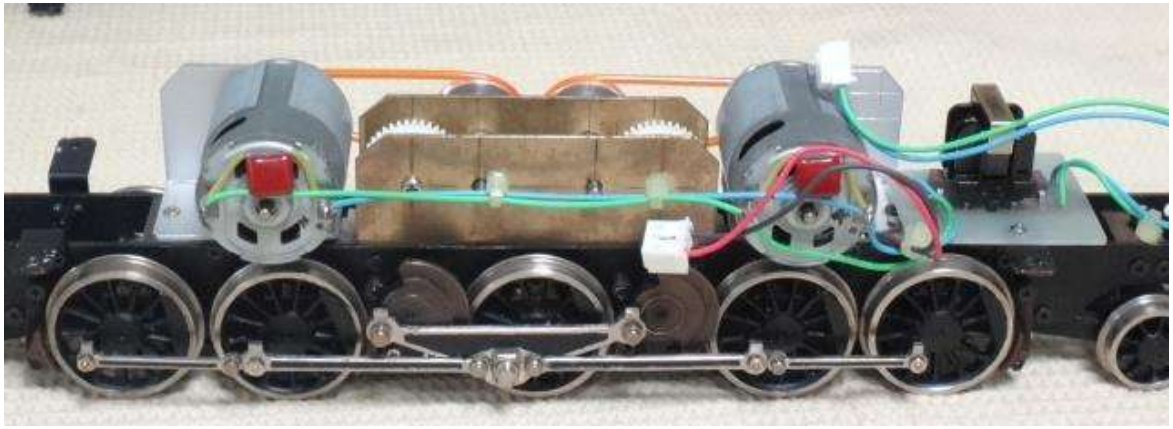
Year of construction 1914.
Weight 107t.
Driving wheel diameter 1350mm.
Manufacturer SLM, BBC.

This is one of the most famous Swiss made electric locomotives. It was designed to haul increasing traffic through the Simplon tunnel and proved to be a great success. However, when introduced, it caused a heavy oscillation damaging rods and scotch yokes - triangular rod was too fragile. After full filling the triangular rods and with another counter measures, the locomotive revealed it's capability to full extent.

Since the five driving wheels are coupled with rods, maneuverability looks bad, but the first and fifth driving wheels form so called Klauss-Helmholz bogie with leading/trailing wheels. By Klauss-Helmholz wheel, the first and fifth driving wheels are given lateral movement at curves.



Since five driving wheels are mounted on a single chassis, the maneouvrability is a problem not only for the original, but for the model as well. Basically, plays are provided for each wheels, the first and fifth driving wheels are slightly thicker than the others to cope with steep curves which generally happens in models.



The model has two motors that drive two driving discs. All the driving wheel and driving discs are synchronized by gear trains equipped inside the frame, because five driving wheel coupling is difficult by only two rods - plays to cope with much steeper curves than the real locomotive, poor precision caused by poor manual work etc. can obstruct smooth running.

References

F.J.G.Haut, The History of Electric Locomotive, George Allen and Unwin, London1969.
Brian Hollingthworth, The great book of Trains, Salamander books 1987.

2B-B2 Alioth locomotive

Modeled in 2017, Scale = 1/45

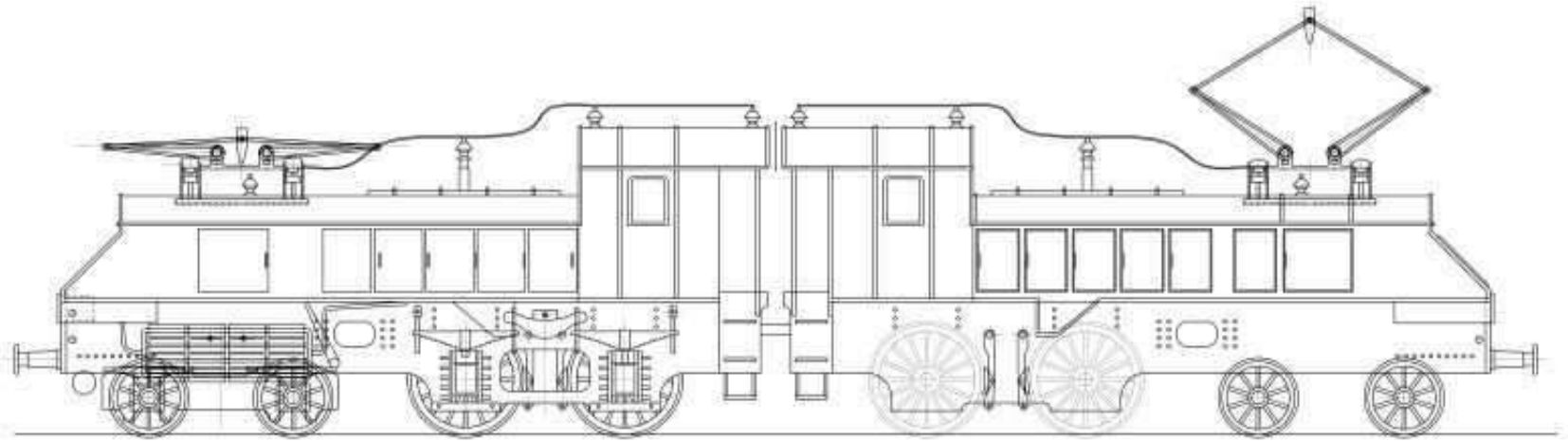
This is a rarity. Only two photos in black and white seem to be existing until today. Neither drawings nor information about the livery. The color in this model is the result of my total imagination. Only some dimensional data are found on books and in the Internet. The locomotive was an experimental one and it run on the lines of Cannes, PLM. Even type number is unknown.

12kV, 25Hz
Length over buffers 20650mm.
Output 1600HP.
Maximum speed 70km/h.

Year of construction 1910.
Weight 136t.
Driving wheel diameter 1500mm.
Manufacturer Societe Alioth, Horme et Buire.

One of the technical structure known is that it used vertically installed motors. By the silhouette of the locomotive, the motor must have driven the first driving wheel only (no space for motor above second driving wheel) and the power is transmitted by gear train to the second driving wheel (short wheel base of the driving wheel).

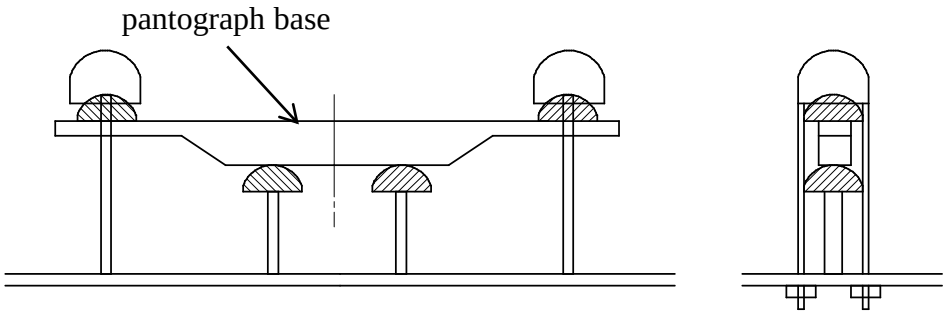
The experiment was said to be successful, but the reason why it was abandoned is unknown.



The wire over the cab seems to be a jumper to connect both pantographs, but this is not clear.

Also, the insulator underneath the pantograph must be the connection to the transformer located in the body, but again this is not sure.

However, the number of spokes of the driving wheel, I counted very carefully and I ma reasonably sure. Above the leading wheels must be the finned pipe for heat exchange.



The shaded ones are the insulators and pantograph base looks like to be sandwiched by those insulators.
Why ? No insulators with bolts available ?

I know the existence of this locomotive for more than forty years, but so little information available and structure of (the base of) pantograph held me back until 2017. Having observed those only two available pictures (but, fortunately, a picture with better resolution is found on the Internet), I eventually came to a conclusion of the structure of pantograph (I can neither prove correct nor incorrect).

References ;
F.J.G.Haut, The History of Electric Locomotive, George Allen and Unwin, London1969.
https://commons.wikimedia.org/wiki/File:2BB2_AF_01_GW.jpg