



# Crocodiles

- The Remarkable Story of the Swiss Electric Locomotives

# Crocodiles

This illustrated talk will explain the Swiss motivation to rapidly electrify their national railway network, challenges presented to deliver suitable electric locomotives resulting in the iconic Crocodile and the resources available to model railroaders.

Summer 1963 with a  
through freight train at  
Yverdon station

Crocodile  
Ce 6/8<sup>ii</sup>  
#14274



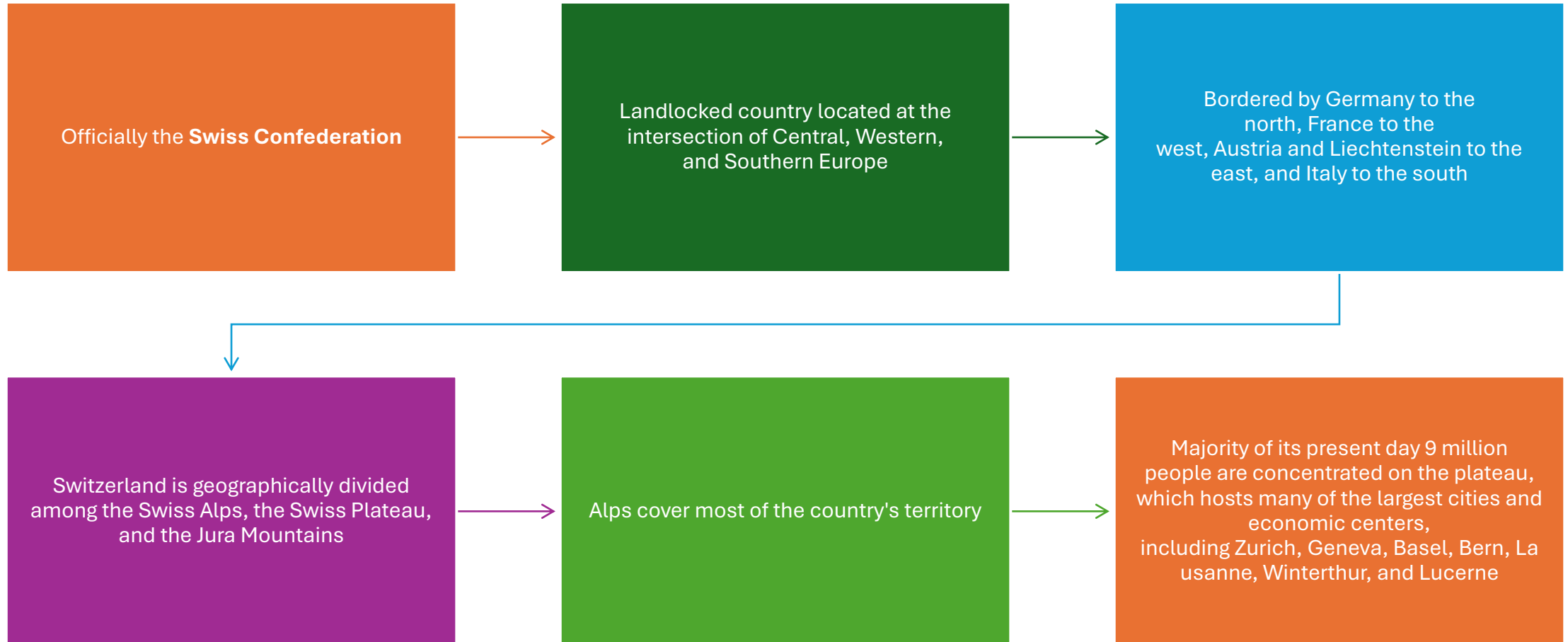
# The Swiss “Krokodil” (Crocodile)

In 2019 the locomotive that came to be nicknamed and beloved by railway folk “Krokodil”, celebrated its centenary

How did this early 20<sup>th</sup> century marvel of electromechanical engineering come into existence and for what purpose?

First let us remind ourselves about Switzerland and helpful abbreviations .....

# Introduction to Switzerland



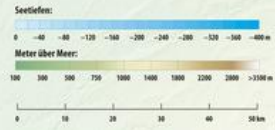
# SCHWEIZ



- Landesgrenze
- Kantons-grenze
- Nationalpark-grenze

- BERN Bundesstadt
- Aarau Kantons-hauptort
- ZÜRICH Stadt mit über 100'000 Einwohnern
- Lucerne Stadt mit über 50'000 Einwohnern
- Genève Stadt mit über 10'000 Einwohnern
- St. Moritz Ortschaft unter 10'000 Einwohnern

- A. Altitouren
- Autobahn/-strasse
- Hauptstrasse
- Nebenstrasse
- Eisenbahn
- Schmalspurbahn



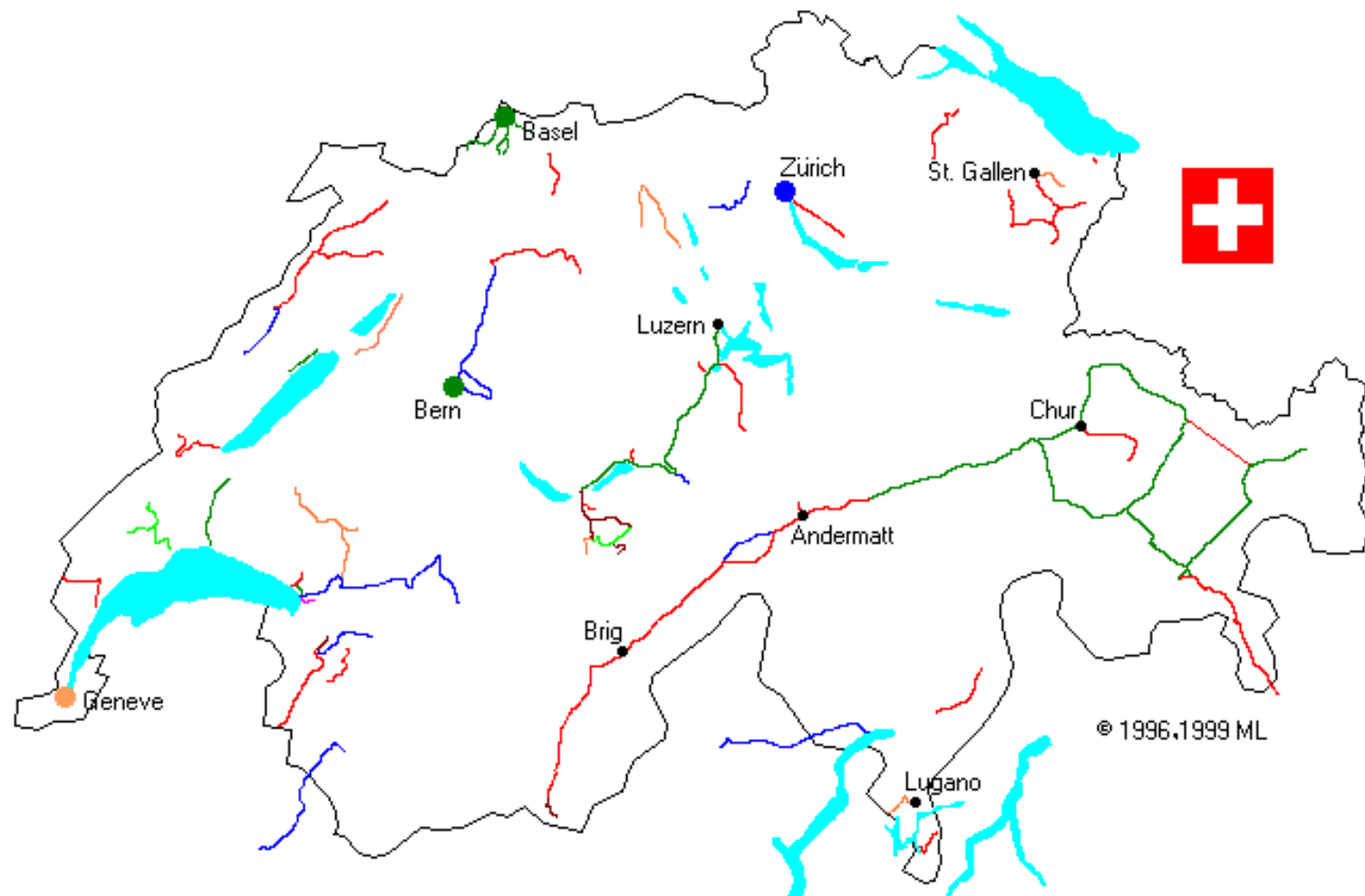
# Present Day Swiss Standard Gauge Mainlines



Liniennetzplan SBB Fernverkehr.

Wir verbinden die Schweiz.

# Present Day Swiss Metre Gauge Mainlines





# Introduction to Swiss Railway Terminology

# Abbreviations

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AC – Alternating Current

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BBC AG – Brown Boveri & Cie, Baden,  
Münchensteirn, Oerlikon, later Bombardier

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DC – Direct Current

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Hz – standard unit of measurement – cycles  
per second

# Abbreviations

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MFO – Maschinenfabrik Oerlikon,  
Zürich Oerlikon, later Bombardier

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SBB – Schweizerische  
Bundesbahnen

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SLM – Schweizerische Locomotiv –  
und Maschinenfabrik, Winterthur,  
later Bombardier and Stadler

# Explanations

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Inductive shunts – manage AC current flow

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Jackshaft - used in locomotives to transfer and redirect rotational power from an engine's crankshaft typically in line with the drive axles connected to them by side rods

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Lay shaft – intermediate shaft within a gearbox

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Side (Coupling) rod – connects the driving wheels



# Swiss Locomotive Classifications (Traditional)

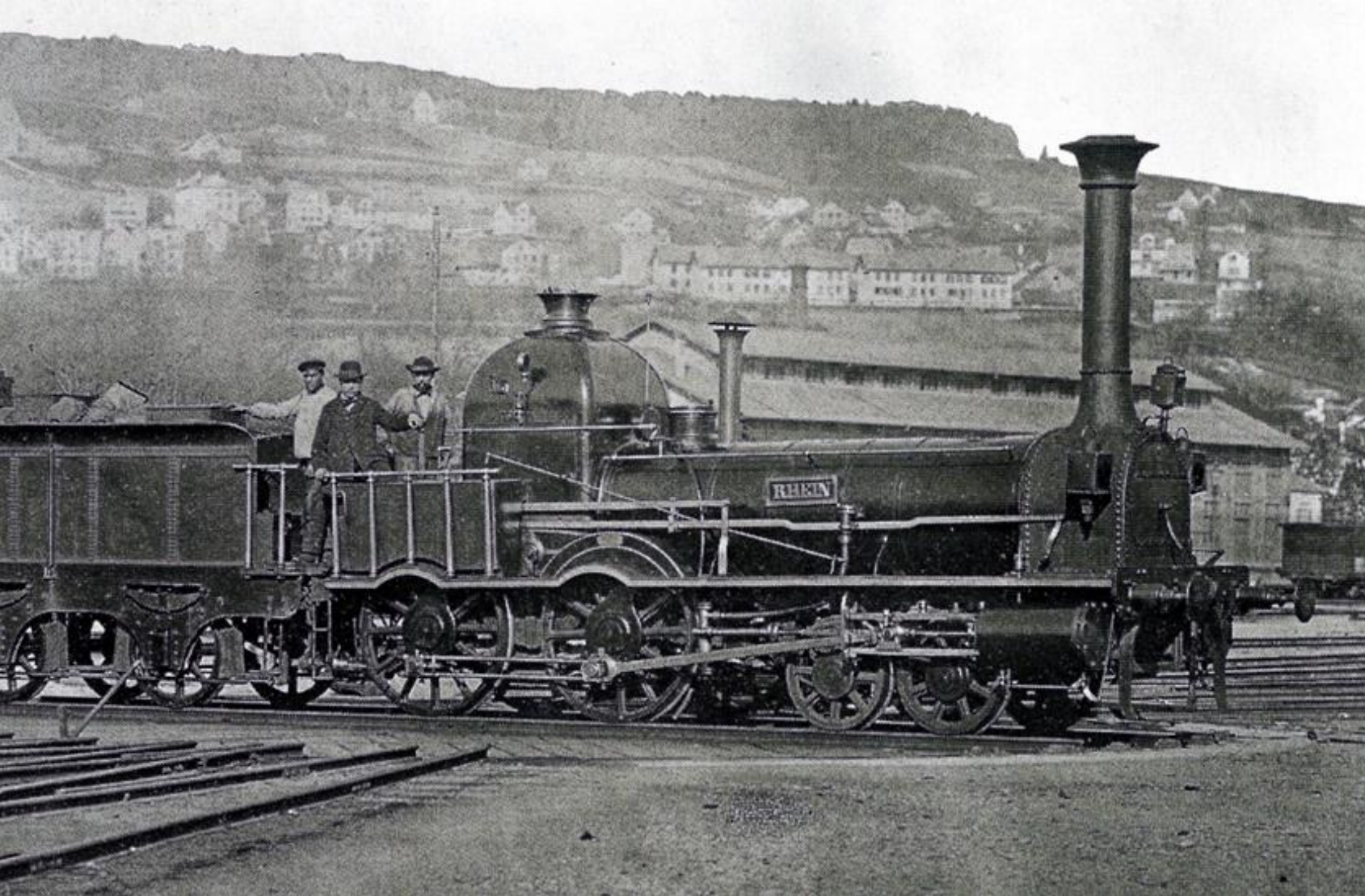
- Employed a series of letters and numbers. Some examples:
  - R = max speed over 110km/h (68mph), A = 85-110 km/h (52-68 mph), B = 70-80 km/h (43-50 mph), C = 60-65 km/h (37-40 mph), D (replaced F) = 45-65 km/h (28-40 mph)
  - G = Narrow gauge adhesion locomotive, H = Rack fitted, A = Battery powered, e = Electric powered, em = Electric & Diesel powered
  - Numbered of powered axels shown against the total number of axels – 4/7 means 4 powered out of a total of 7
  - Roman numbers i, ii, iii, iv used in superscript after the axel count to indicate differences in construction in same series
  - Examples: Fc 2x3/4 (later Ce 6/8<sup>i</sup>), Re 4/4i, HGe 4/4<sup>iii</sup>,

# Coming of railways

Swiss were slow to start a railway network



First route wholly within Switzerland opened in 1847



**Nachricht an das reiselustige Publikum.**

— 2152550 —

Fahrten-Tabelle vom 1. Mai 1847.

# SCHWEIZERISCHE NORDBAHN

in 30 Minuten  
VON  
**ZÜRICH NACH BADEN.**

**DAMPFSCHIFFE** AUF DEM **ZÜRICH- UND WALLENSEER**  
in einem Tag von **ZÜRICH** nach **CHUR, St. Gallen** etc.

Bei direkter Verbindung mit Mailand, sowie mit allen Städten am Rhein, Belgien, Holland und Frankreich: London, Hamburg, St. Petersburg u. s. w. sowohl durch Dampfschiffe als Eisenbahnen.

**FAHRTEN-TABELLE**  
DURCH  
**SCHWEIZER. NORDBAHN**

vom 1. Mai 1848 bis auf weitere Anzeige

In einem Tag  
VON  
**ZÜRICH NACH FRANKFURT** A. M.

(Die täglichen Fahrten nach PARIS etc. werden später bekannt gemacht.)

Avis important.	Wichtige Nachricht.	Important Advice.
En partant de Zurich à 3 heures du matin, on arrive	Die von 3 Uhr Morgens von Zürich abgeh. Züge an	On leaving Zurich at 3 o'clock in the m. one arrives
à Baden à 5 1/2 heures du matin.	in Baden um 5 1/2 Uhr Morgens.	at Baden at 5 1/2 o'clock in the morning
- Aarau - 7 - - -	- Aarau - 7 - - -	- Aarau - 7 - - -
- Olten - 10 - - -	- Olten - 10 - - -	- Olten - 10 - - -
- Fribourg - 12 - - -	- Fribourg - 12 - - -	- Fribourg - 12 - - -
- Carlsruhe - 3 - - -	- Carlsruhe - 3 - - -	- Carlsruhe - 3 - - -
- Frankfurt - 9 - - -	- Frankfurt - 9 - - -	- Frankfurt - 9 - - -

**Alle Visitationen an den Gränz-Mauthantern sind bei direkten Fahrten — aufgehoben.**

Schweizerische Nordbahn - 1847



## ***Spanisch-Brötli***

- 1700's Brötli were very popular among wealthy people of Zürich
- A traditional Swiss flaky puff pastry specialty from Baden
- Filled with roasted hazelnuts, sugar, and apricot jam, and shaped into a distinct, cross-scored square. It requires chilled puff pastry, a ground hazelnut mixture, and apricot jam, baked at 200°C–220°C until golden




## ***Spanisch-Brötli- Bahn***

- Servants traveled 25 km to Baden by foot over night to purchase Brötli to bring them back to Zürich for breakfast
- 1847 SNB connected Zürich and Baden
- Spanisch Brötli now reached Zürich in 45 minutes
- SNB became known as the "Spanisch-Brötli-Bahn"

# Coming of railways

Swiss quickly understood the properly planned national network



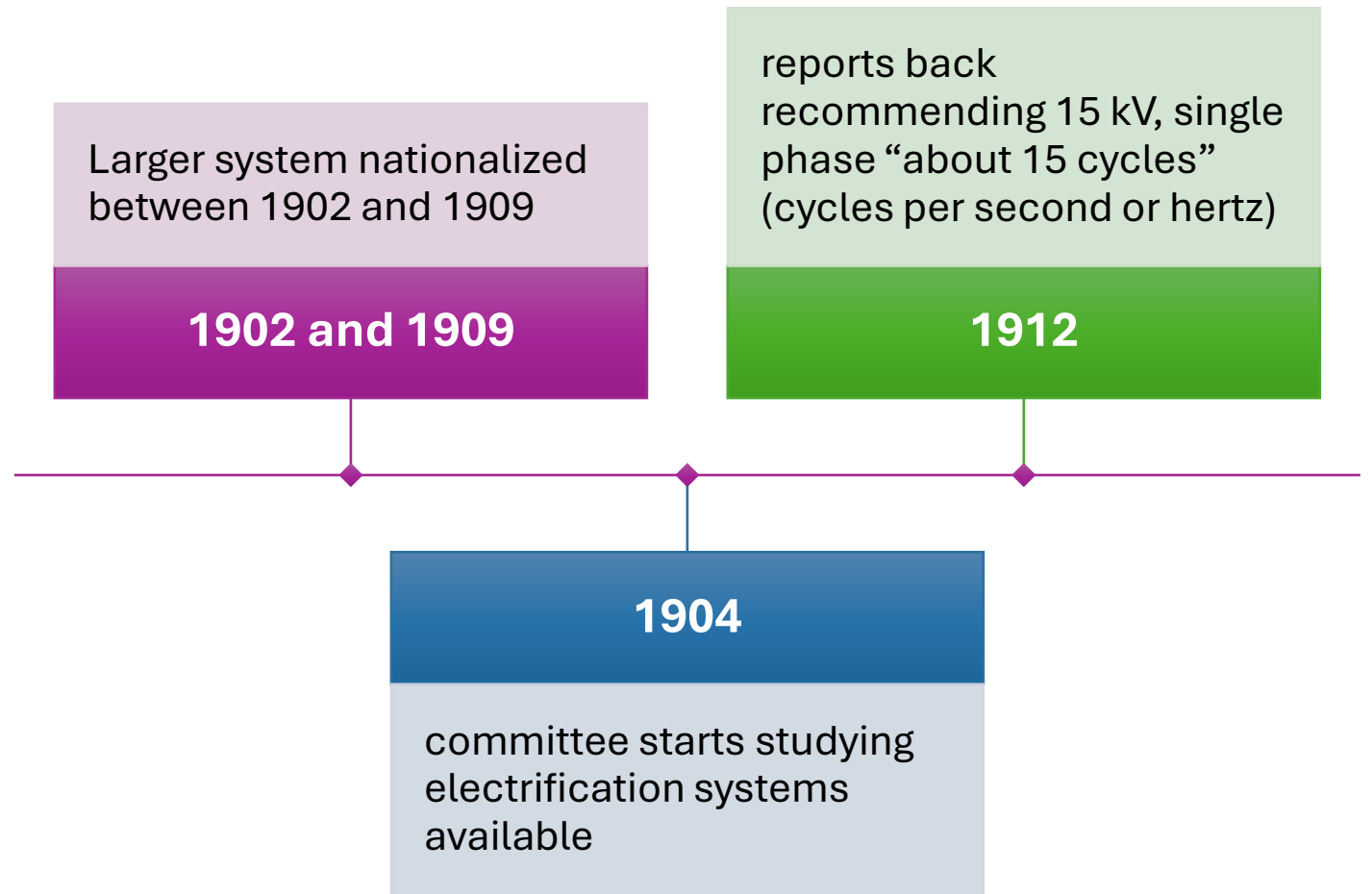
1850 Robert Stephenson (son of George) commissioned to plan a base network running south-west to north-east through most populated area



## Robert Stephenson 1803 - 1859

- Only son of George Stevenson  
“Father of Railways”
- Civil engineer
- Has been called the greatest  
engineer of the 19<sup>th</sup> century

# Coming of railways



# Coming of railways

During the period of committee deliberations

- MFO carried out trials 15kV 16 2/3<sup>rd</sup> cycles trials on the Seebach-Wettingen line near Zurich and
- Largest independent Bern Lötschberg Simplon (BLS) main line

After a hesitant start, SBB adopted 15kV 16 2/3<sup>rd</sup> cycles

Following war's end in 1918, freight traffic soon exceeded pre 1914 levels resulting in the urgent need for powerful locomotives



## Swiss Steam Classic at War's End

- A 3/5
- SLM
- 1902-1922
- 111 Built



## Swiss Steam Classic at War's End

- C 5/6
- SLM
- 1913 – 1917
- 28 Built

## Steam to Electrification motivation

Motivated by the lack of coal for steam locomotives and the desire to use an abundance of naturally available hydroelectric power, SBB electrification moved at considerable speed

By end of 1940's vast majority of SBB network was electrified, with only a few routes retaining steam until 1960

# Railway Electrification

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Most early electrification schemes involved ***suburban or underground*** railways

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Easily-controlled, low voltage, direct current to trains relatively simple, efficient robust DC motors

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Substations house transformers, switch-gear, other equipment to convert AC to DC

# Railway Electrification

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Significant disadvantage - need to feed overhead wires through large trackside substations every 12km (7.5 miles) or so for a 1,500-volt system

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Early substations housed continually manned rotary converters

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Requires high-voltage main laid beside railway

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Suburban electrification schemes not suitable for challenging alpine environment

# Railway Electrification - Solution

Solution chosen was alternating current (AC) at higher voltage (15,000 volts  $16^{2/3}$  Hz or - Cycles per second)

Simplified trackside installations eliminating AC to DC conversion

Extended trackside intervals to 35 km (22 miles)

Voltage reduced on locomotive suitable for traction motors

Controlled by varying the coils on a transformer - "Tap-changing"

Disadvantage – motors larger and less efficient

# 16 kV 2/3 Hz Railway Electrification

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Developed in German-speaking countries to overcome the technical limitations of early AC motors allowing them to operate at low speeds

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Established as exactly one-third of the European 50 Hz national grid frequency

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Simplified the construction of rotary converters used to convert grid power to railway power

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Allowed for better commutator motor design

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Adopted in Germany, Austria & Switzerland

# Early Swiss Electric Locomotives

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Derived their mechanical construction from steam locomotives

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Relatively large coupled driving wheels

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Pony axel trucks to reduce axel load & guide locomotive through curves – significant challenge in alpine environment

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Transformer and motors housed within a body mounted on a frame

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Pairs of motors geared to a common lay shaft, connected to coupling rods

# Early Swiss Electric Locomotives

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Powering through rods has disadvantage  
can only transmit horizontally so power  
rises and falls with each wheel rotation

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Mitigated by placing rods one side of  
locomotive at 90 degrees to other side,  
careful to ensure always have tractive force

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This led to the development of Büchli drive  
to enable constant driving force throughout  
each revolution of the wheels

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For a time, Büchli drive had a competitor  
Tschanz system but not adopted in  
Switzerland apparently on ground of weight

# Büchli drive

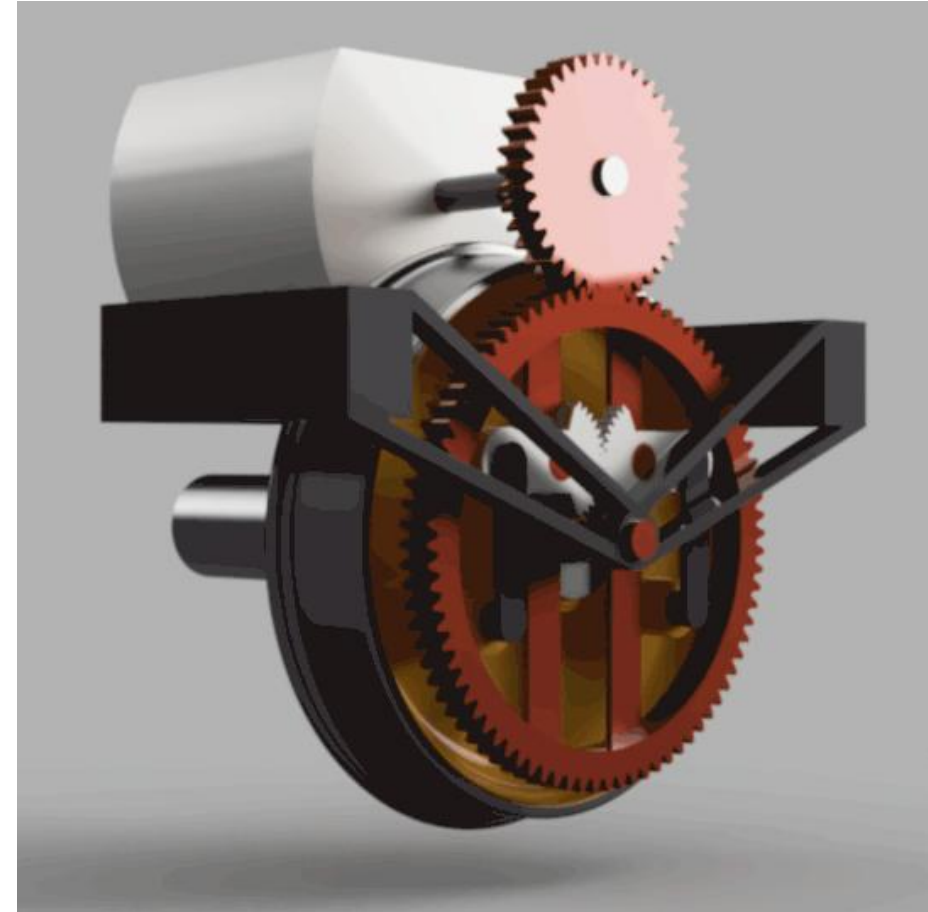
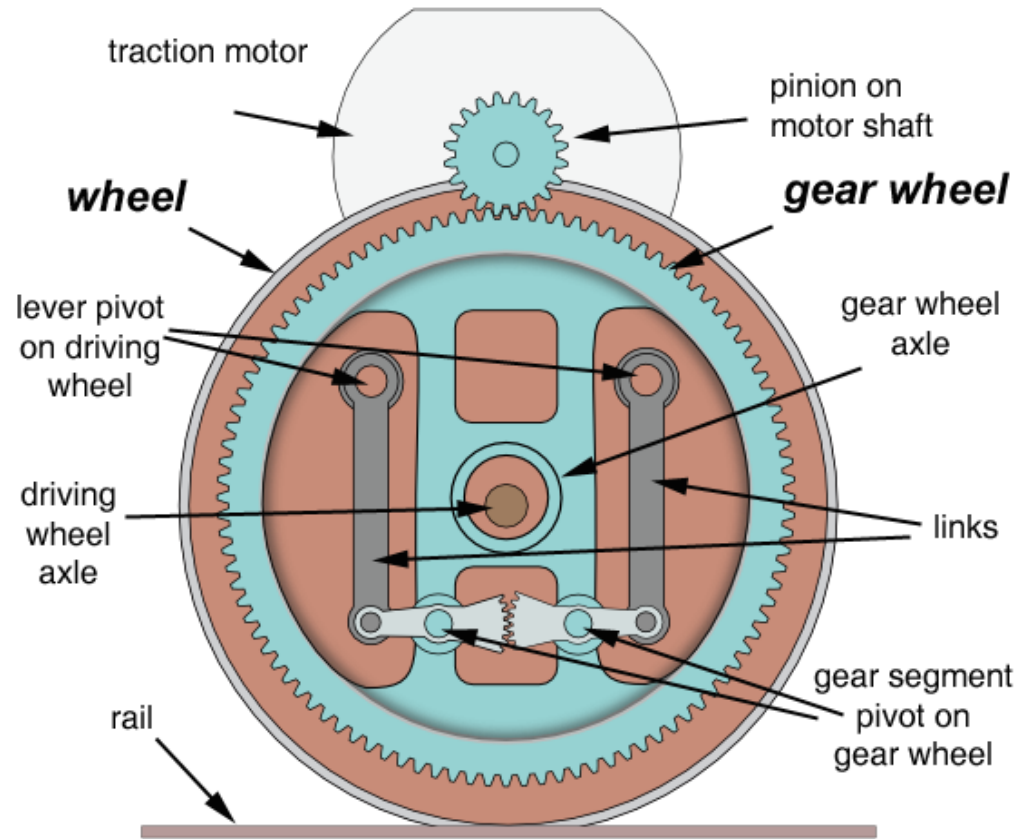
Gear wheel is securely fixed to the locomotive frame

Inside this gear wheel are two levers, coupled to gear segments that mesh with one another

The other end of the levers is coupled via universal joints to tension bars, which are then coupled via more universal joints to the driving rail wheel

Disadvantage of the drive was the large number of moving parts, which demanded frequent lubrication and careful maintenance

# Büchli drive



# SBB in search of electric locomotives

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There was no time for extensive prototype testing

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Four Prototype locomotives ordered in 1917

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The solution produced for the heavy freight (4<sup>th</sup> prototype) proved a design masterpiece and an instant success for over half century of service

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Helpful to first understand traditional Swiss Locomotive Classifications ....

SBB orders  
four  
prototypes in  
1917

The year is significant since SBB  
were under considerable pressure  
to handle the rising traffic demand



The four prototypes in order

Fb 2x2/3 11301

Be 3/5 12201

Fb 2x2/3 11302  
later Be 4/6  
12302

Fc 2x3/4 12201  
became Ce  
6/8<sup>i</sup> 14201

## SBB orders production in 1917

Time pressure required  
production ordering before the  
prototypes were delivered!

With the speed of electrification  
in the 1920s, saw the SBB order  
some 480 electric locomotives  
across a dozen designs

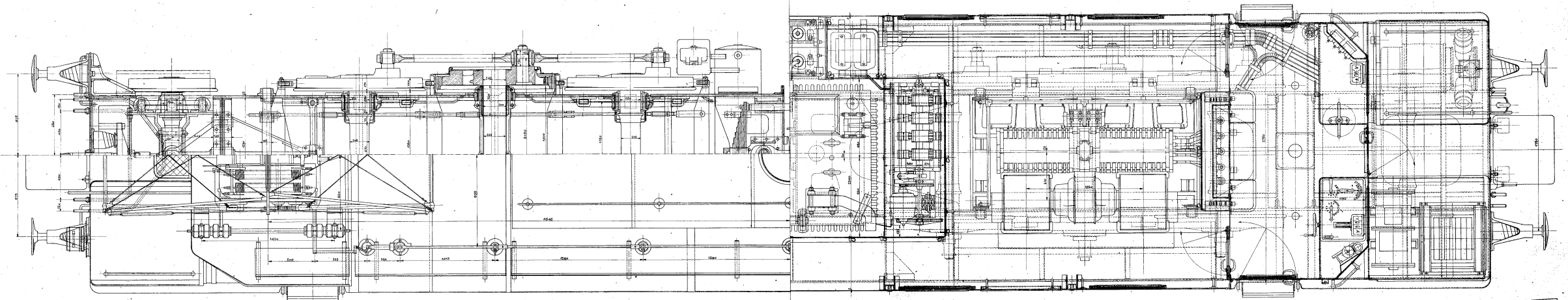
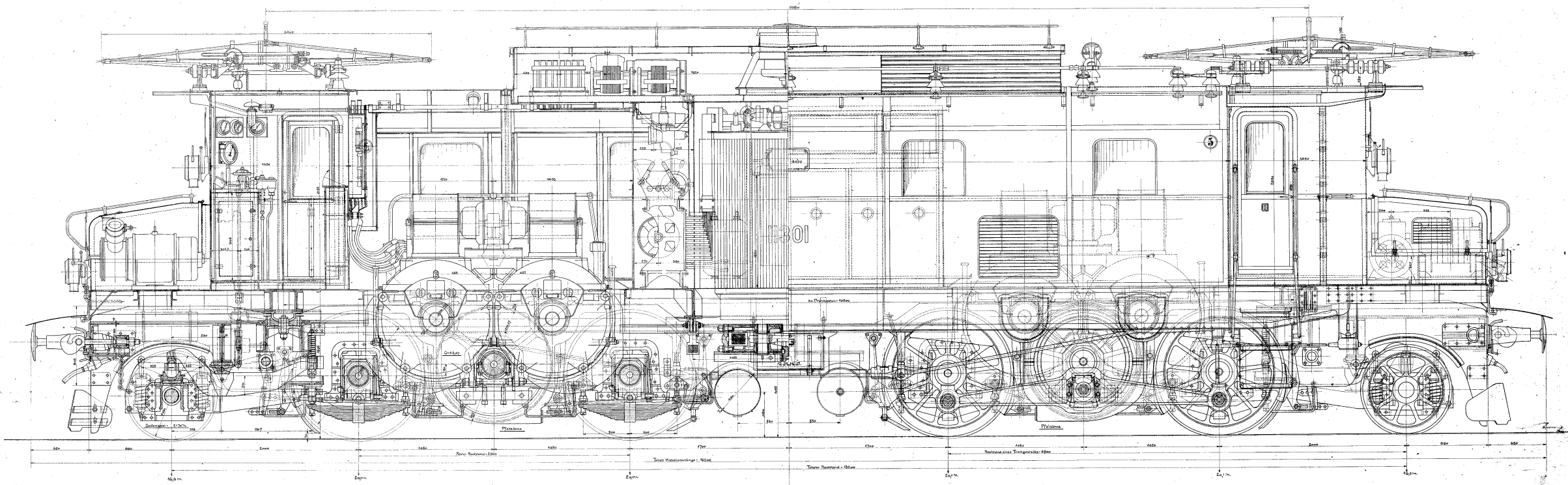
# 1<sup>st</sup> of the four prototypes

First Built by SLM with electrical equipment by from MFO  
Fb 2x2/3 11301 unofficially known as the “Doryphore”  
(Potato Beetle) as had small bonnets at the outer ends

Built by SLM with electrical equipment from MFO

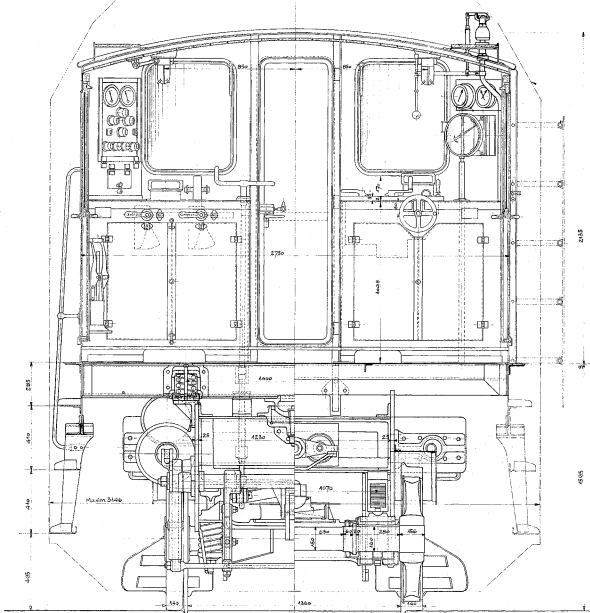
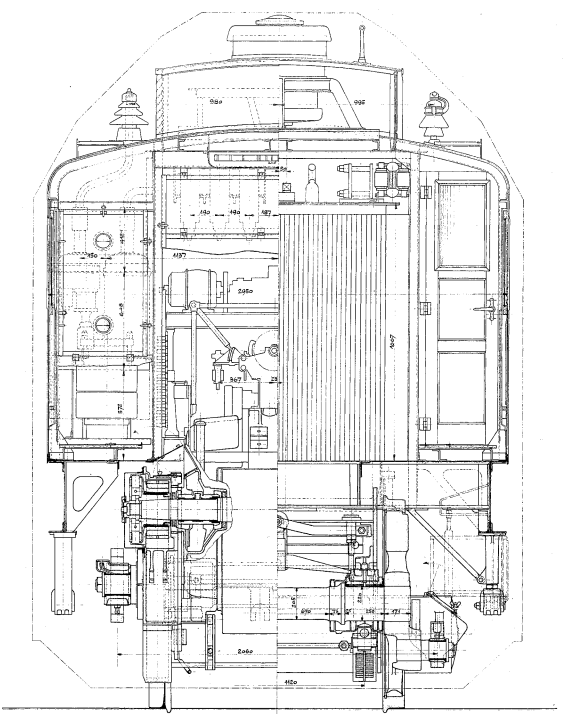
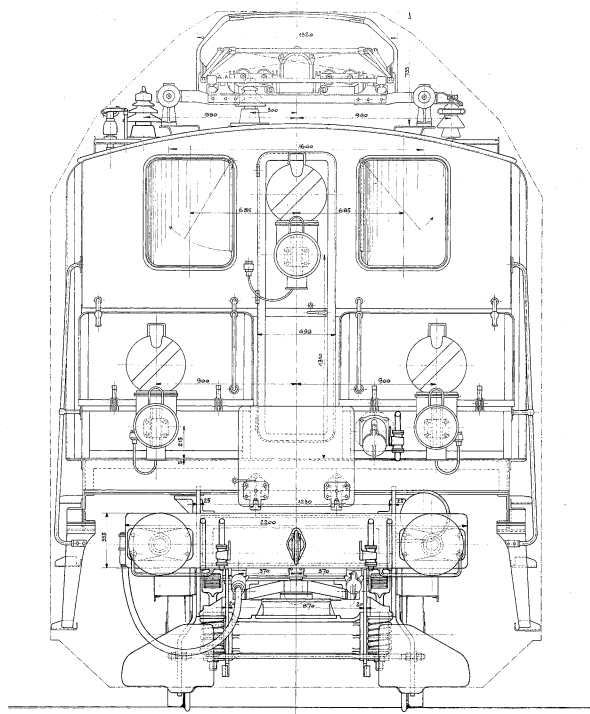
Be 4/6<sup>i</sup> format

Went to Bern for trials as an express passenger locomotive



MFO Division  
 1939  
 11750

Be 4/6  
 1301  
 Loc. N° 1301 | O.L. 5005/430  
 LN 209494



**Type: 1B-B1**  
**Elektrische Lokomotive S.B.B.**

Maßstab: 1:10

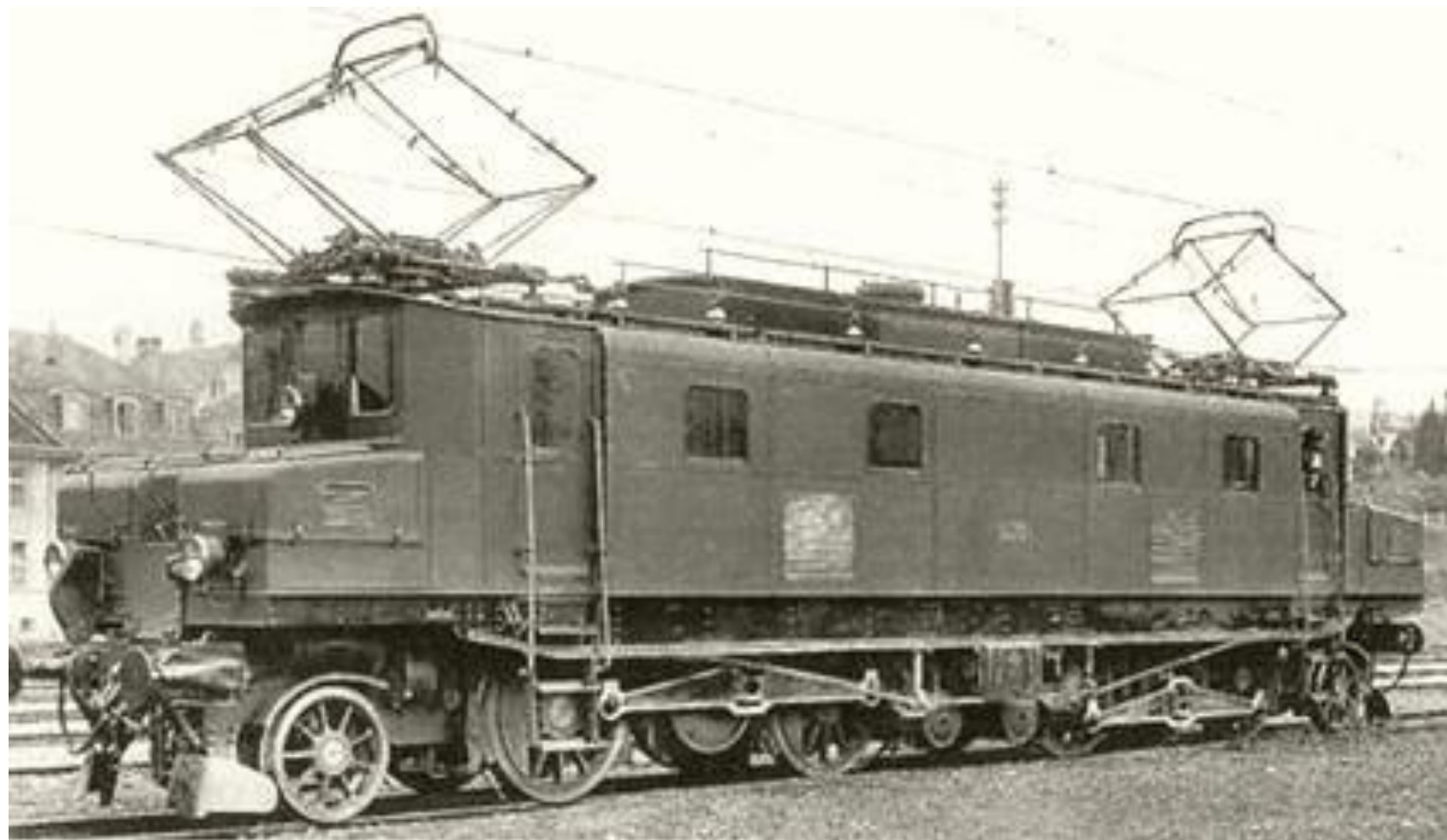
Legende:

Spannweite	1438 mm
Wagelänge über Puffer	15200 mm
Torster Radstand	15200 mm
Torster Radstand pro Triebgestell	3800 mm
Triebgestellabstand	11390 mm
Laufachsenabstand	980 mm
Zentralachsversetzung	43,47 mm
Spannung	15000 Volt
Periode	16 2/3 Hz
Powerleistung	1800 kW bei 60 km/h
Normleistung (Stromleistung)	2250 kW bei 60 km/h
Maximalleistung (1h Stunde)	2750 kW bei 60 km/h
Normale Geschwindigkeit	50 km/h
Maximale Geschwindigkeit	75 km/h
Normale Zugkraft	15200 kg
Maximale Zugkraft (Strom)	18000 kg
Gesamt des oberen Teiles	50,4 m
Gesamt des unteren Teiles	54,2 m
Gesamt der Bauhöhe	104,6 m
Triebgestell	113,9 m
Periode	80,4 m

Wintner, 20-8-10, 44

[LN|209501]

Fb 2x2/3  
11301 (Later  
Be 4/6  
12301)



## 2<sup>nd</sup> of the four prototypes

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Supplied in 1919 was Fb 3/5 11201  
later known as Be 3/5 12201

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Also made by SLM/MFO

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Also tested between Bern and Brig then  
transferred to the Gotthard

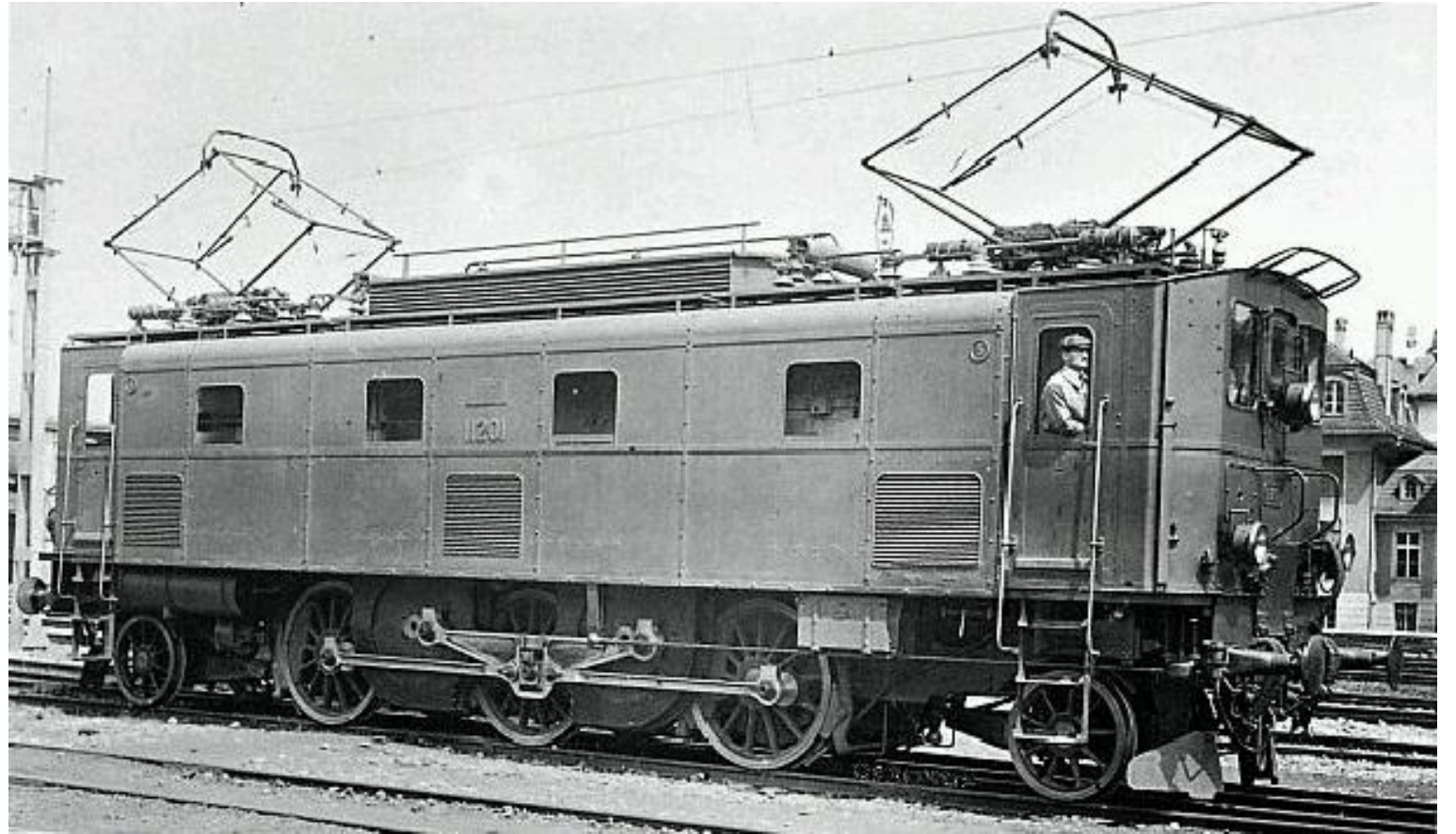
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Unofficially named “Langsame Bertha”  
(Slow Bertha)

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Lived to be finally scrapped at Yverdon  
in 1973

Fb 3/5  
11201 (Later  
Be 3/5  
12201)



3<sup>rd</sup> of the four  
prototypes

Built in 1919 designated Fb  
2x2/3 11302 later Be 4/6 12302

Built by SLM with electrical  
equipment by BBC

Unlike 11301/12301 had full-  
length, full-height body

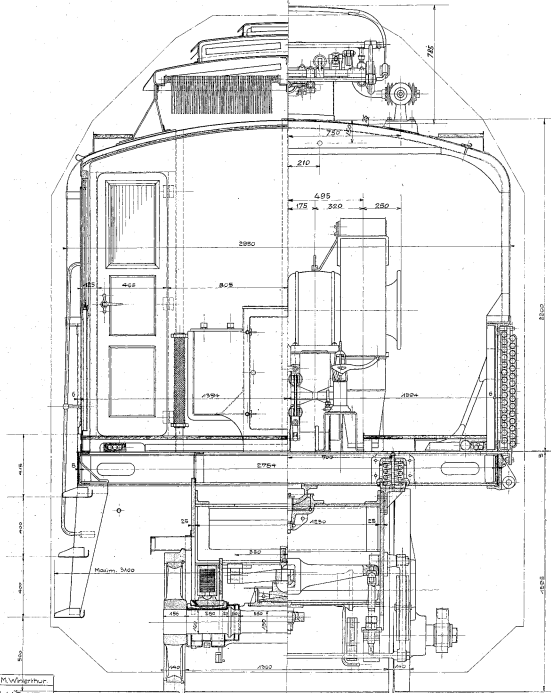
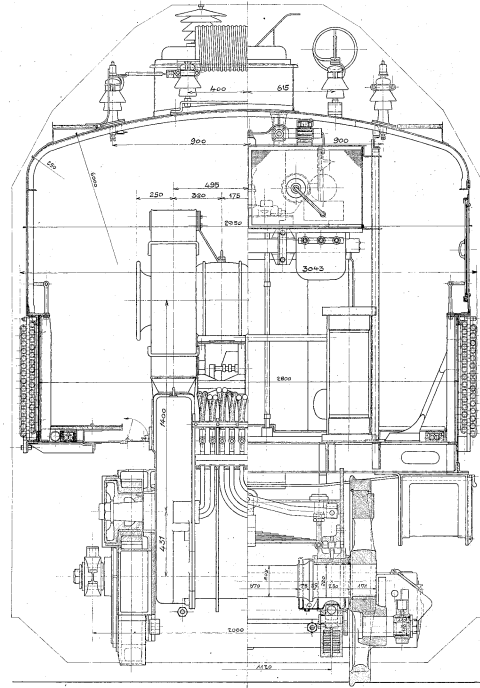
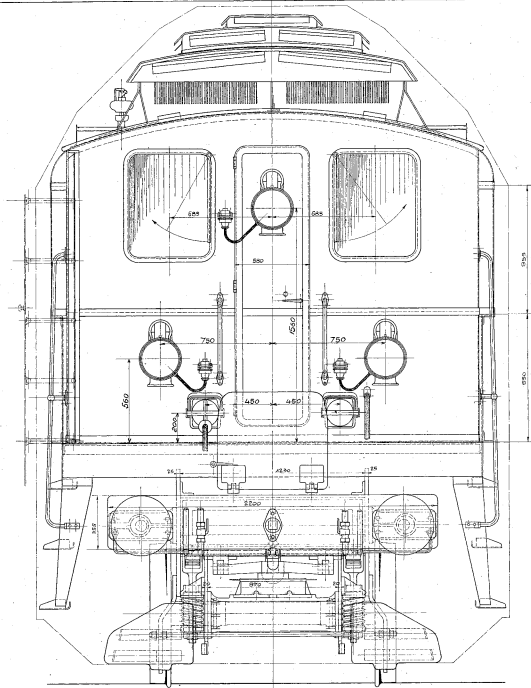
## 3<sup>rd</sup> of the four prototypes

Transformer was housed in a cabinet without cooling fins; rather hot oil was pumped through long pipes running length of locomotive

Said to waddle at high speed!

Scrapped in 1965 following short-circuit in the transformer





**Type 1B-B1**  
**Elektrische Locomotive S.B.B.**

— Masstab: 1:10 —

**Legende:**

Spurweite .....	1435 mm
Tiefe Lange der Roller .....	4250 mm
Toller-Rollerabstand .....	4350 mm
Roller-Rollerabstand pro Triebgestell .....	3300 mm
Triebachsabstand .....	4350 mm
Laufachsabstand .....	9000 mm
Zahnradubersetzung .....	4:175
Fuhrspannung .....	4800/7500 Volt
Rollerabstand .....	46 1/4
Dauerleistung am Radumfang .....	1840 PS
Normalleistung (Dauerleistung) .....	1200 PS
Maximalleistung (4 Stunden) .....	1800 PS
Normale Geschwindigkeit .....	50 km/h
Maximale Geschwindigkeit .....	75 km/h
Normale Zugkraft .....	12000 kg
Maximale Zugkraft (Erdbeben) .....	18000 kg
Gewicht des leeren Teiles .....	30 t
Gewicht des leeren Teiles .....	37 t
Gewicht der Ausrustung .....	40 t
Teilegewicht .....	108 t
Mindestgewicht .....	75 t

LN 209500

Winterthur, den 19. Februar 1919

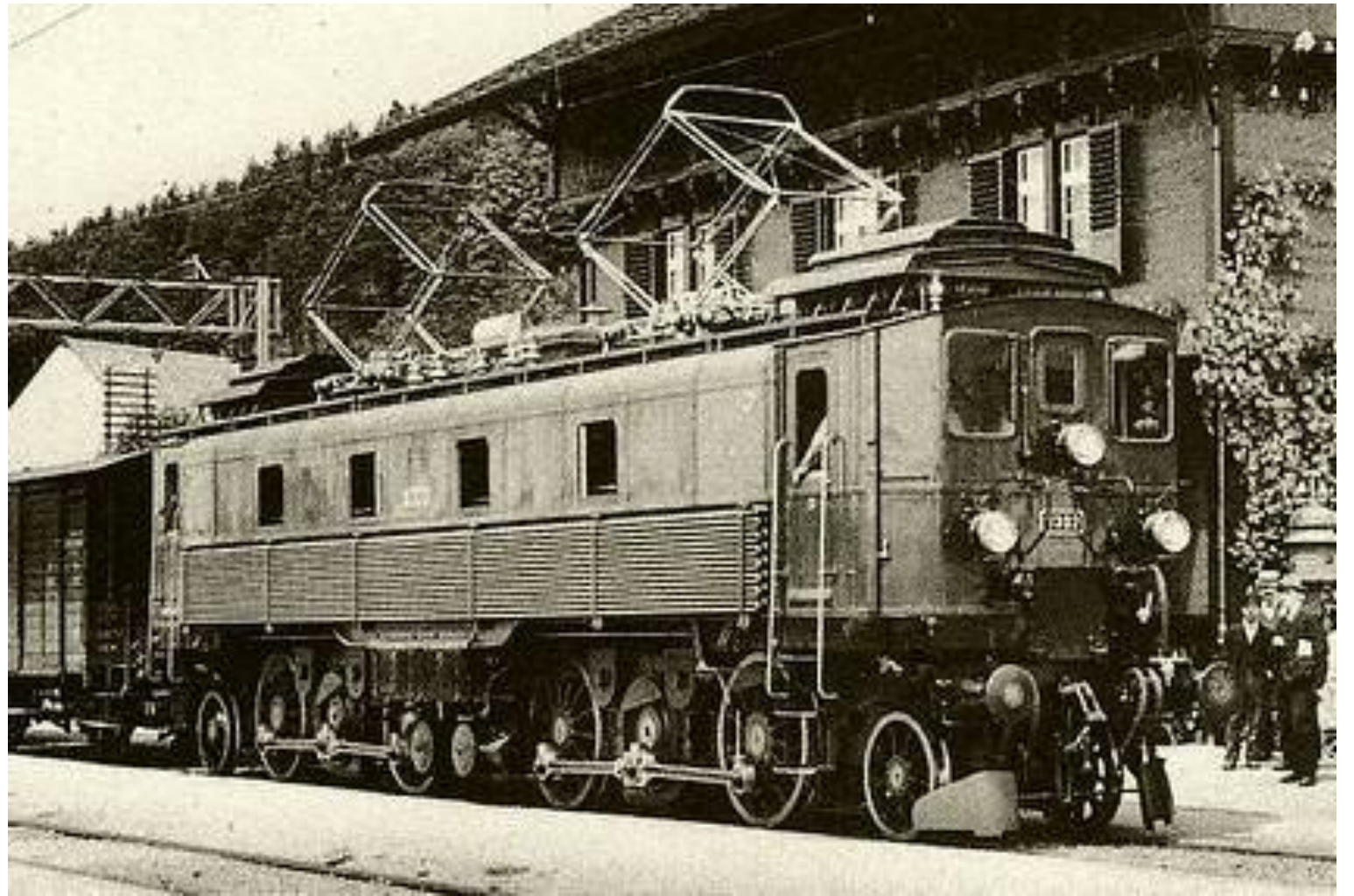
Be 4/6 I 12302 neu

S.L. 11047

Loc. 1B 11302

O.L. 5006/451

Fb 2x2/3  
11302 (later  
Be 4/6  
12302)



## 4<sup>th</sup> of the four prototypes

Unlike the first three prototypes, the fourth was designed as a heavy freight locomotive

Fc 2x3/4 12201 became Ce 6/8<sup>i</sup> 14201 shortly after delivery

Built by SLM and BBC

Apparently original intention was to produce a 0-6-6-0 per Whyte classification

## 4<sup>th</sup> of the four prototypes

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Small bonnets added both ends over the leading axels to provide improved weight distribution and cornering on the demanding 2.6% Gotthard

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Regenerative braking was incorporated but proved unsuccessful and removed in 1931

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Ran extensive tests 1919/20 Bern Spiez and BLS main line

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Transferred to the Gotthard in 1921 and used there until 1937

4<sup>th</sup> prototype  
– SBB's  
Demanding  
Specification

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Capability to haul a train of 860 tonnes from Arth-Goldau to Chiasso and back twice (700km / 435 miles) within 28 hours

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Assistance provided on gradients exceeding 1%

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Top speed 65km/h on 1% with 300 tonne load

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Overcome gradient of 2.6% with 430 tonnes @ 35 Km/h (21.7mph) or 300 tonnes @ 50 km/h (31mph)

Köfferlilok Ce 6/8<sup>i</sup>  
("Suitcase Loco")

## Gotthard Route

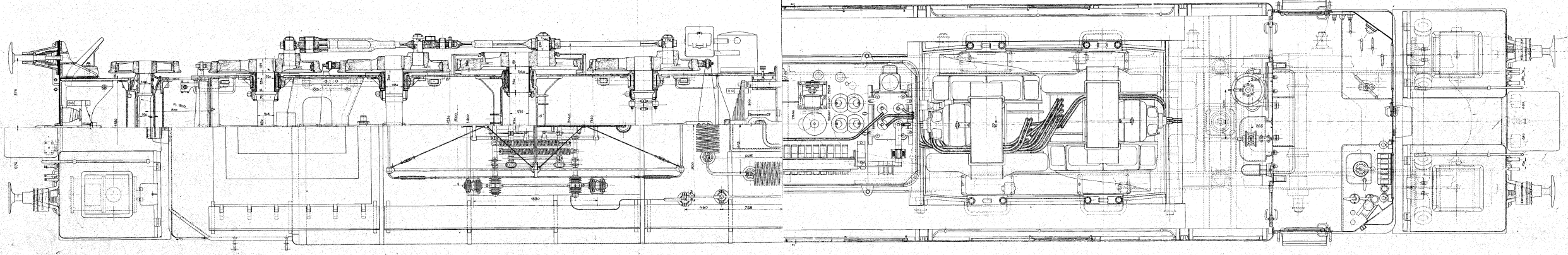
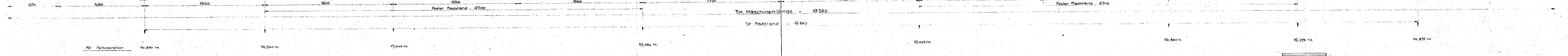
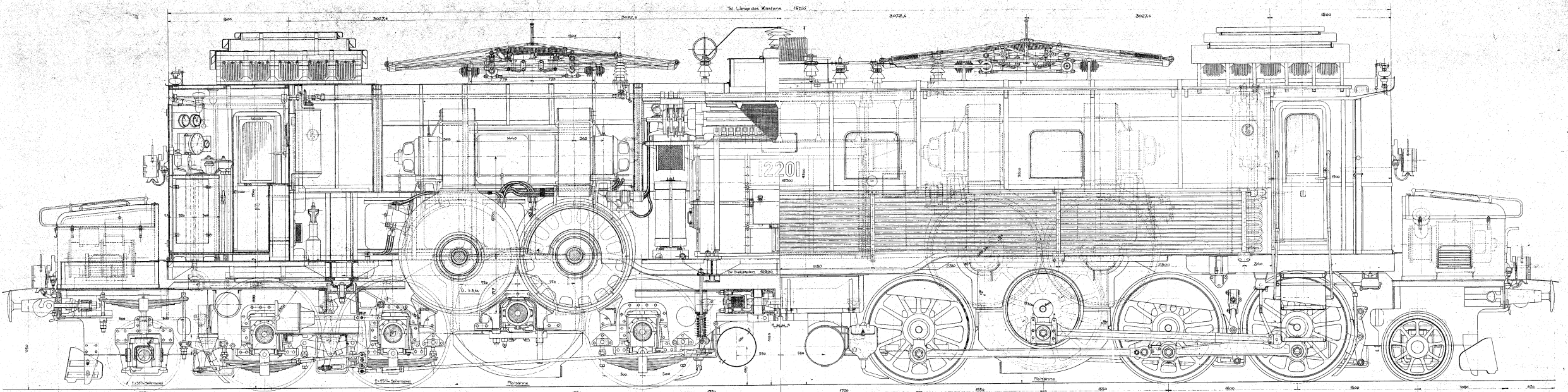


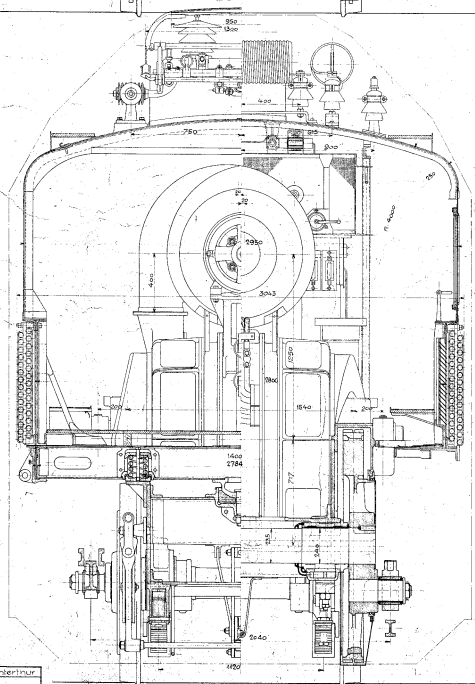
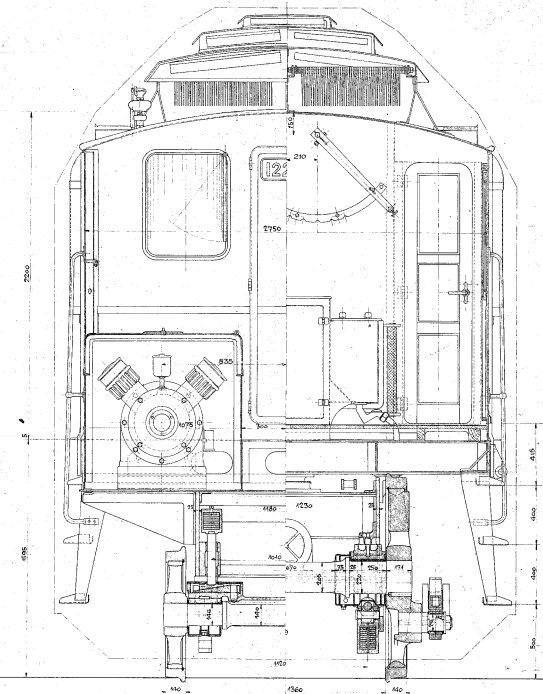
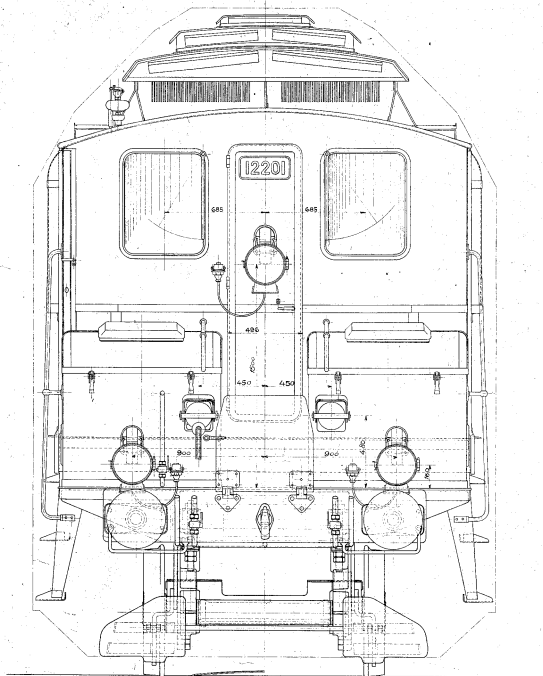
# Design Concept

Engineers conceived articulated design for two reasons

- Axle load limitations dictated mechanical & electrical components be distributed over number of axles
- The curve nature of the Gotthard route required flexibility

The Ce 6/8 12201 (later 14201) was born





## Type IC-C1 Elektrische Locomotive SBB.

— Massstab : 1 : 10 —

### Legende

Spurweite	1435 mm
Totale Länge über Puffer	19540
Totale Radabstand	19500
Rad- Radstand pro Triebgestell	4700
Triebständerabmesser	1550
Laufradabmesser	850
Zentralübertragung	1 : 3,74
Fahrerstromspannung	1500/2000 Volt
Requisitwert	16,15
Drehleistung (elektr. der)	1540 PS
Normalleistung (Nennleistung)	1350 PS
Nominale Geschwindigkeit	60 km/h
Maximale Geschwindigkeit	65 km/h
Normale Zugkraft (1931)	45500 kg
Maximale Zugkraft (Gegewinn)	27000 kg
Gewicht des elektrischen Teiles	35115 kg
Gewicht des mechan. Teiles	7020
Gewicht der Ausrüstung	1485
Totale Masse	43620 kg
Stützlast	35,115

Verformung bei 8 Tonn.

S. V. M. Weberstrass  
L. N.º 12116

Ce 9/8  
L. N.º 12201  
O.L. 5007/451

Köfferlilok  
Ce 6/8<sup>i</sup>  
("Suitcase  
Loco")





## Design Concept

Unofficially named Kofferlilok  
("Suitcase Loco")

More recently became known as the  
Grossmutter ("Grandmother") fore-  
runner to celebrated "Crocodiles"

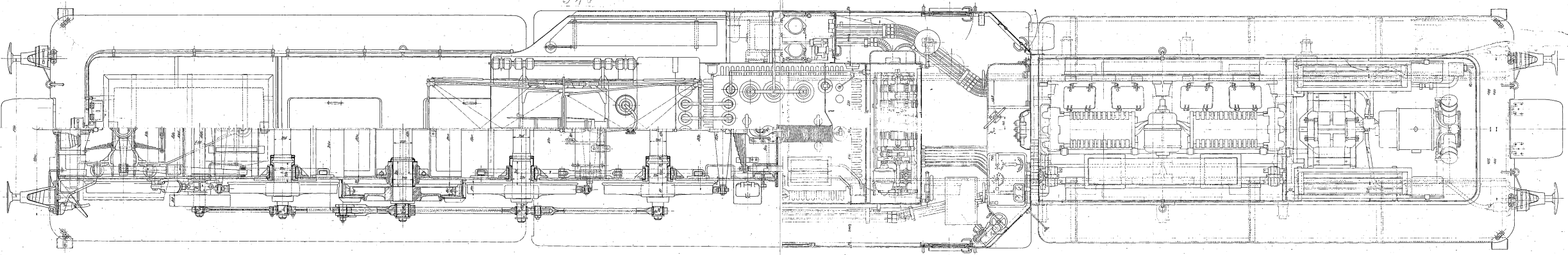
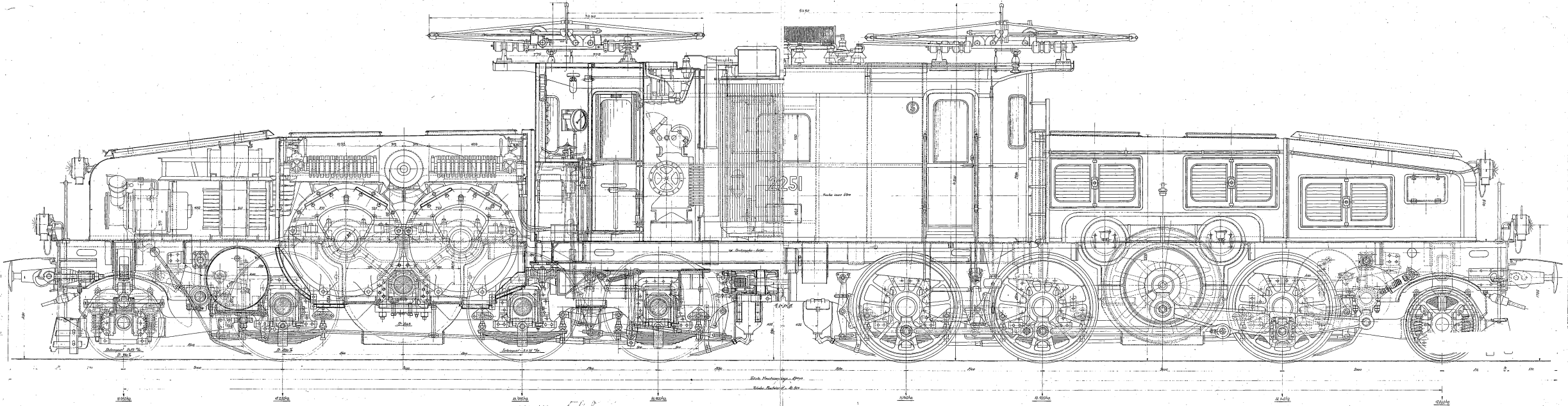
Not withdrawn until 1982 & passed  
into preservation

# From Prototype to Production

The Crocodiles are born!

In 1918 an order placed with SLM / MFO for 33 machines

The first four were branded Fc 6/8s 12251-12254 and appeared from November 1919 but did not start work until 1920



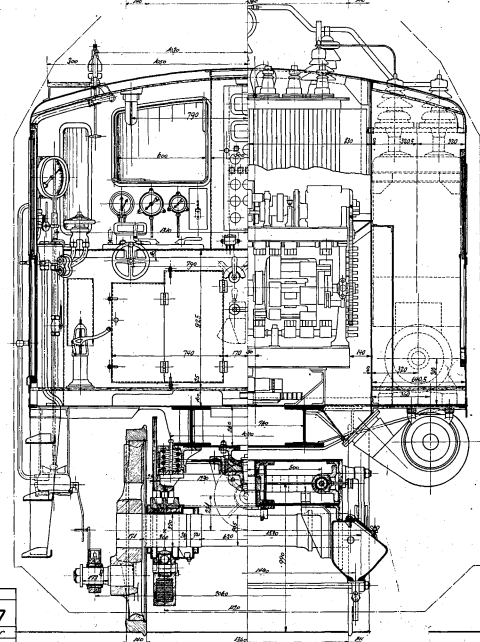
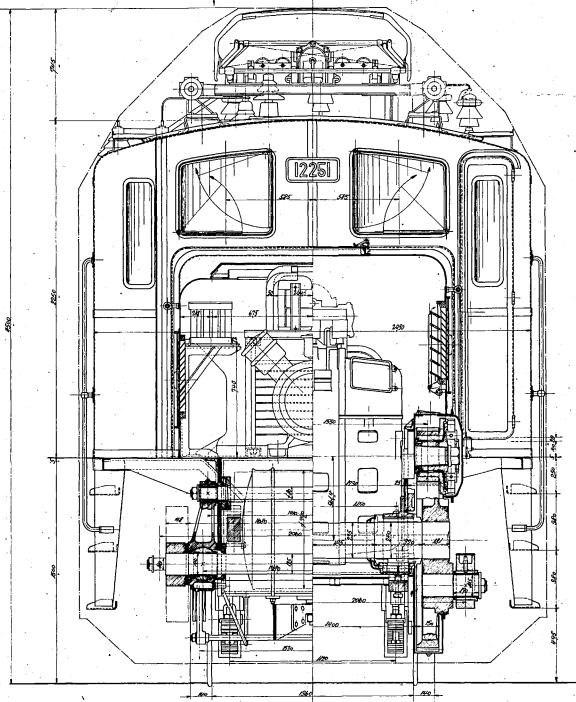
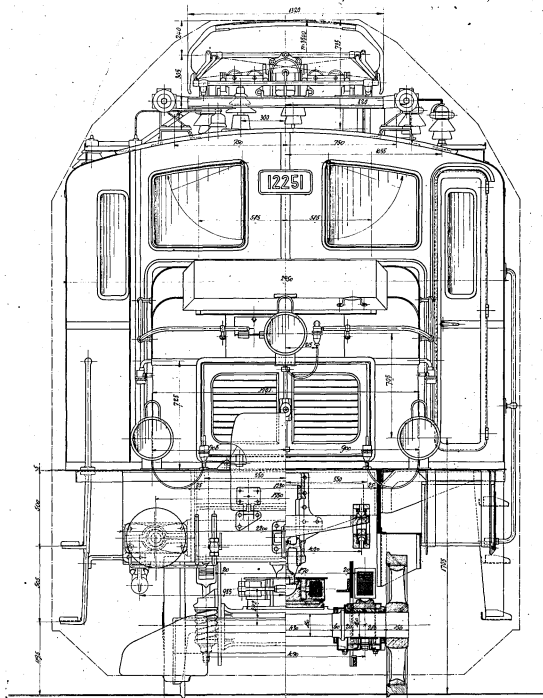
LN 200708  
 22/2/1953  
 22/2/1953

548

548

M 1:20

Be 46 (1951) OL 510/45



— Type 1C+C1 —

Elektrische Lokomotive S.B.B.

Modell 1/4

— Lokomotive —

Spanne	1935 mm
Wellehöhe über Mittel	1900 mm
Welleabstand	1800 mm
Welleabstand pro Radpaar	900 mm
Radabstandsmasse	2700 kg
Leertariffgewicht	7500 kg
Zugkraftleistung	11500
Leertariffgewicht	16000 kg
Bruttogewicht	18000 kg
Leertariffgewicht	2000 kg
Bruttogewicht	2200 kg
Leertariffgewicht	2600 kg
Leertariffgewicht	3500 kg
Bruttogewicht	3700 kg
Leertariffgewicht	3900 kg
Bruttogewicht	4100 kg
Leertariffgewicht	5500 kg
Bruttogewicht	5700 kg
Leertariffgewicht	5900 kg
Bruttogewicht	6100 kg

Elektrische Lokomotive  
S.B.B. 1900  
Göteborg 1900

M.F.O. Göttingen  
Zeh. N. 131397  
S. Z. M. 11854  
Zeh. N. 11854

LN 200931

Se 6/8 " (C 6/8) . H 1:20

OL 5110  
OL 5115 / 451

## From Prototype to Production

---

The 33 strong class appeared as Ce 6/8<sup>ii</sup> between 1919 – 1922 and all then numbered 14251-14283

---

At first carried a livery of cinnabar red & vermilion with black chassis, later SBB switched to chocolate brown

---

In 1928 SBB switched to pine green with grey underframes



Ce 6/8 ii  
14270 @  
Erstfeld



Ce 6/8<sup>ii</sup>  
#14253  
Erstfeld

# Innovative Electrical Equipment

Electric traction development was progressing rapidly

SBB agreed developments incorporated as being built

Resulted in significant differences between locomotives

- +ve at the time
- -ve for maintenance staff who had to be aware of all the peculiarities

# Innovative Electrical Equipment

Transformers, main switches and tap changers housed in body between each driver cab

Transformers could be fed with either 7.5 kV or 15 kV single phase AC at 16 2/3<sup>rd</sup> cycles from two diamond pantographs on the roof

In 1920's with significant steam operations, soot built up on the catenary and smoke hanging in tunnels a problem

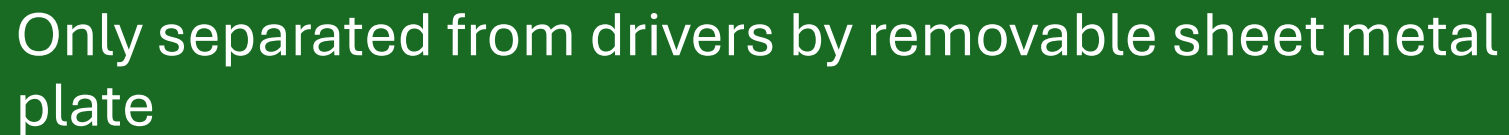
To mitigate risk of flashovers and short circuits, catenary in tunnels fed at 7.5 kV at the outset

# Innovative Electrical Equipment

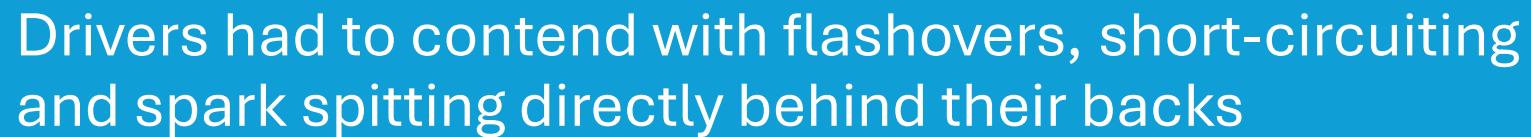
Speed was controlled with electro-mechanical 23 notch tap-changers



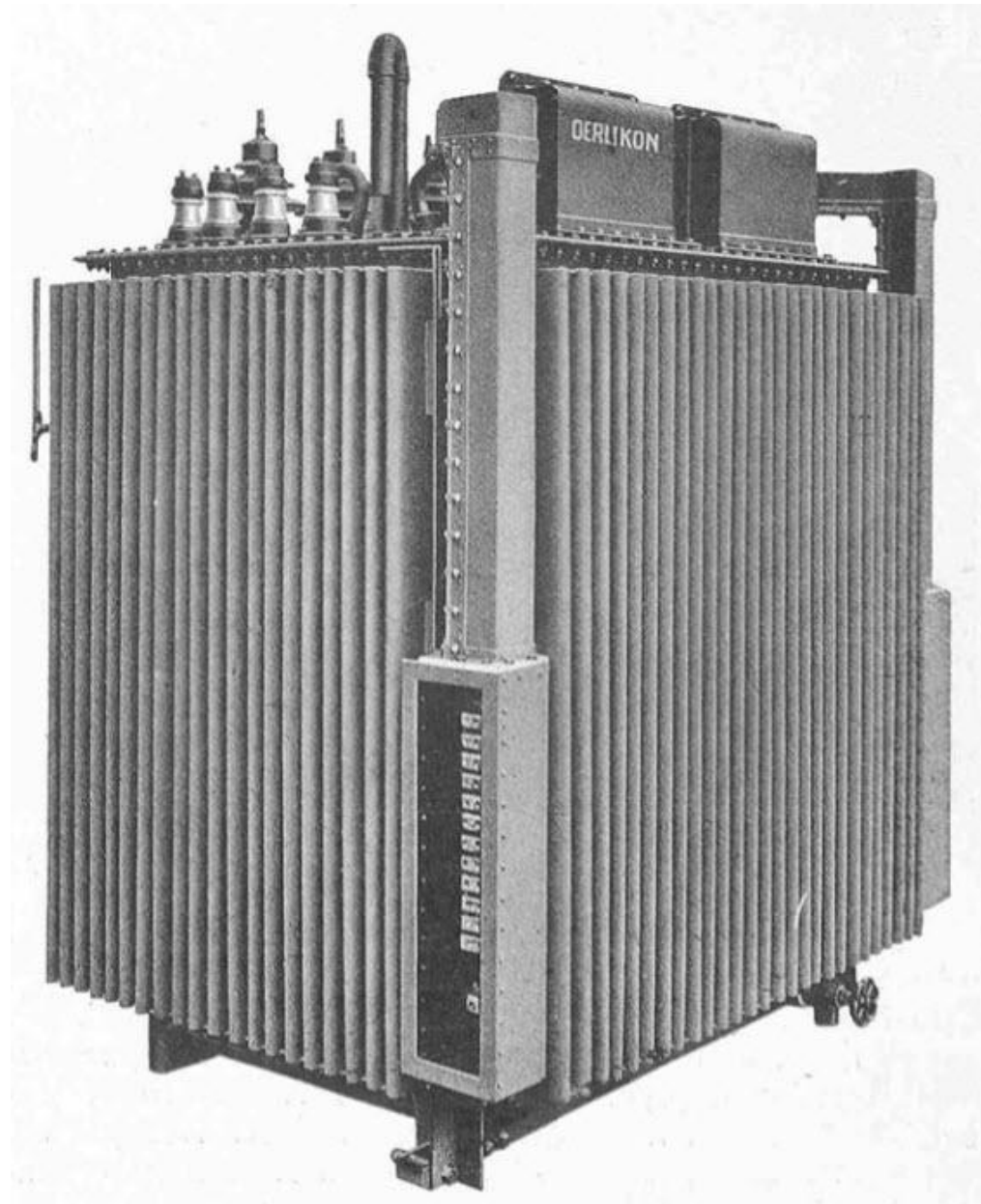
Only separated from drivers by removable sheet metal plate



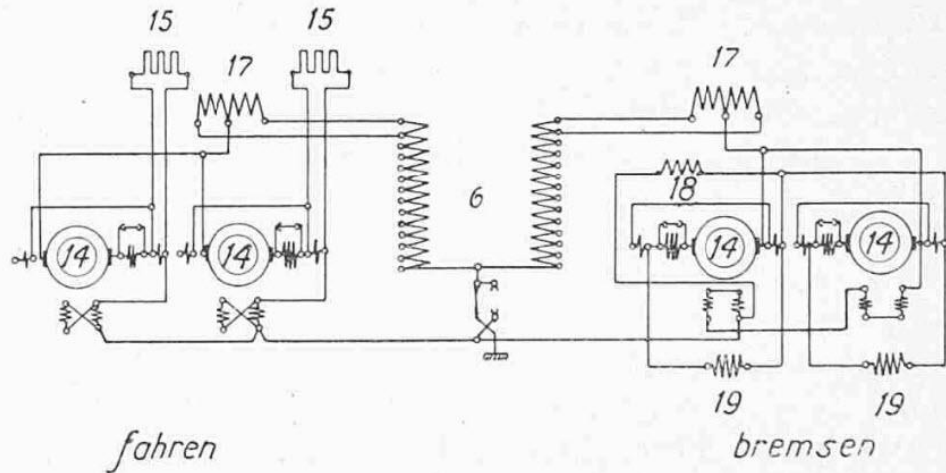
Drivers had to contend with flashovers, short-circuiting and spark spitting directly behind their backs



Main  
transformer of  
locomotives  
14251–14273,  
excluding  
14264



# Traction motor circuits of the Crocodile locomotive. Drive left, brake right.



LEGENDE: 6 Sekundärwicklung des Stufentransformators, 14 Triebmotoren, 15 Ohm'sche Shunts, 17 Uberschalt-Drosselspule, 18 Brems-Drosselspule, 19 Induktive Shunts.

6 – Secondary winding of the step transformer

14 – Drive motors

15 – Ohm shunts

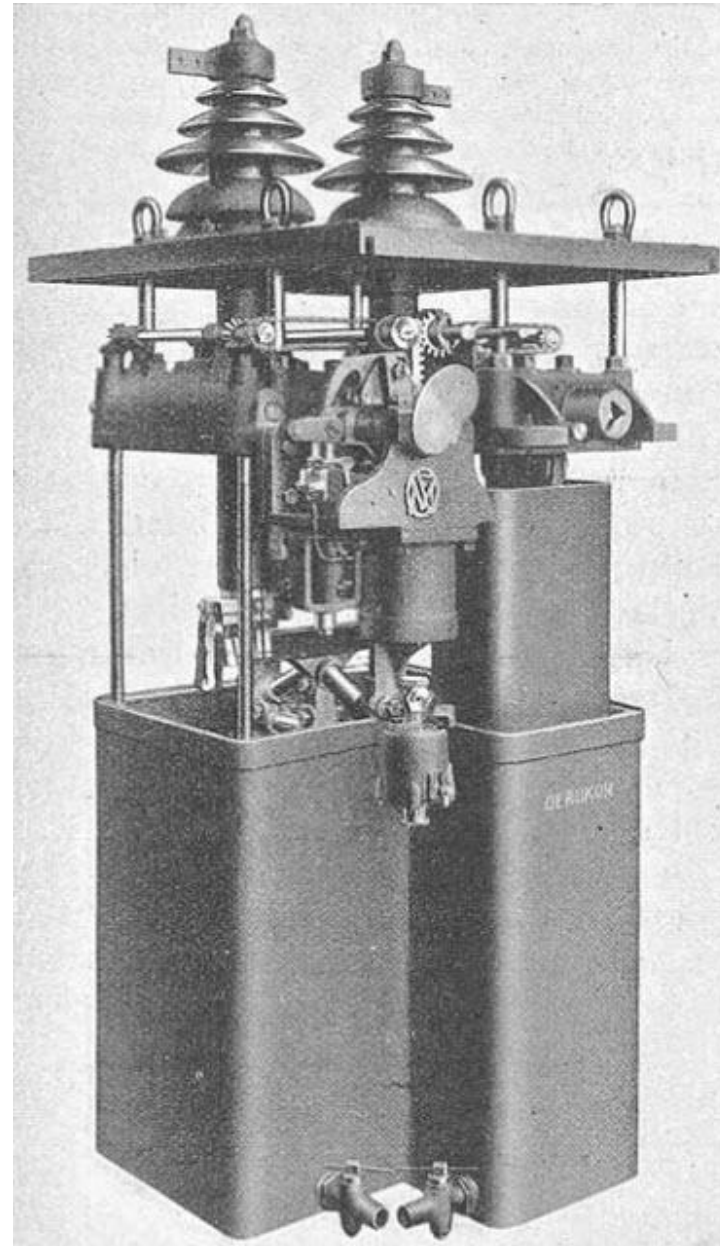
17 – Overrun choke coil

18 – Brake throttle coil

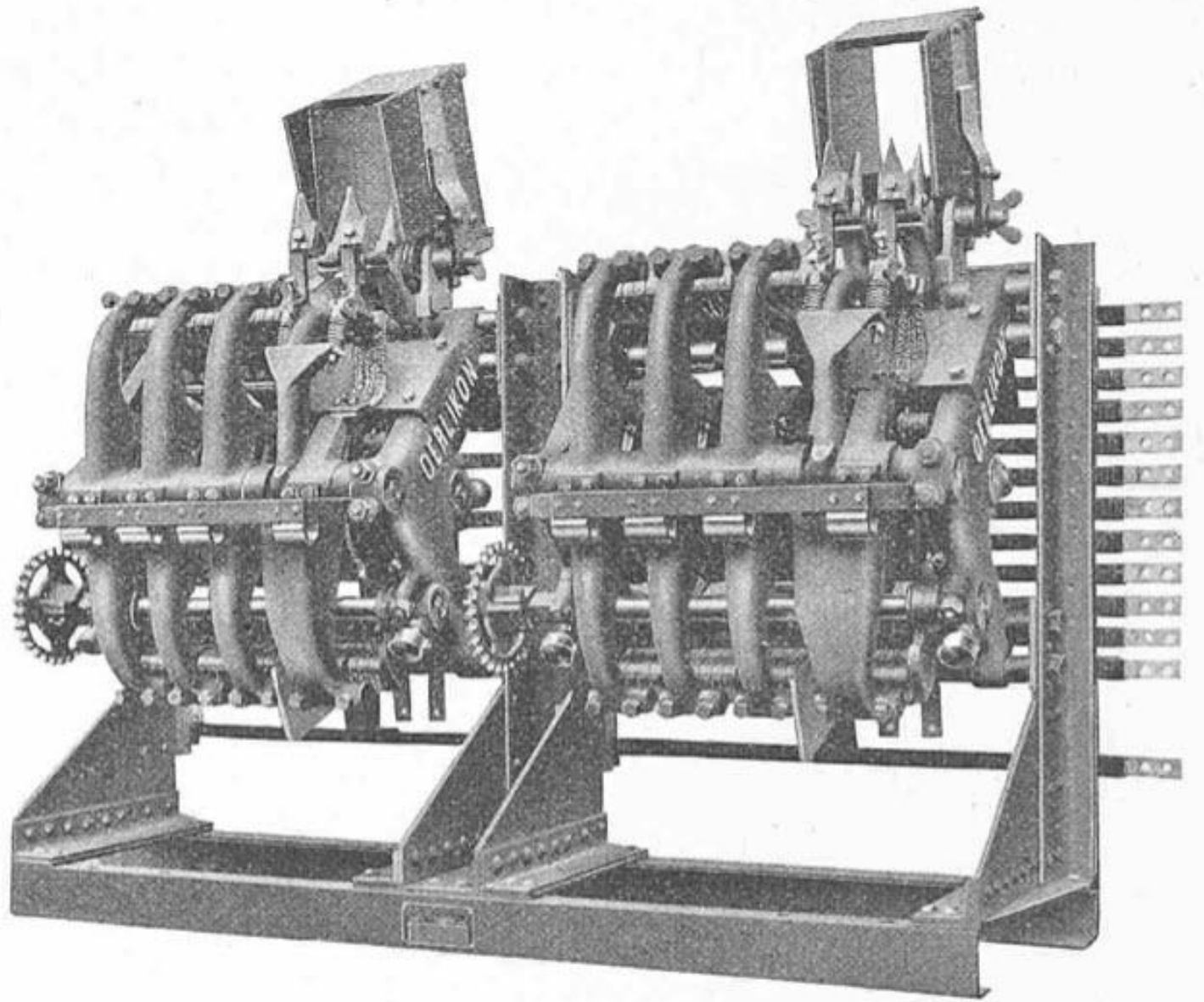
19 – Inductive shunts



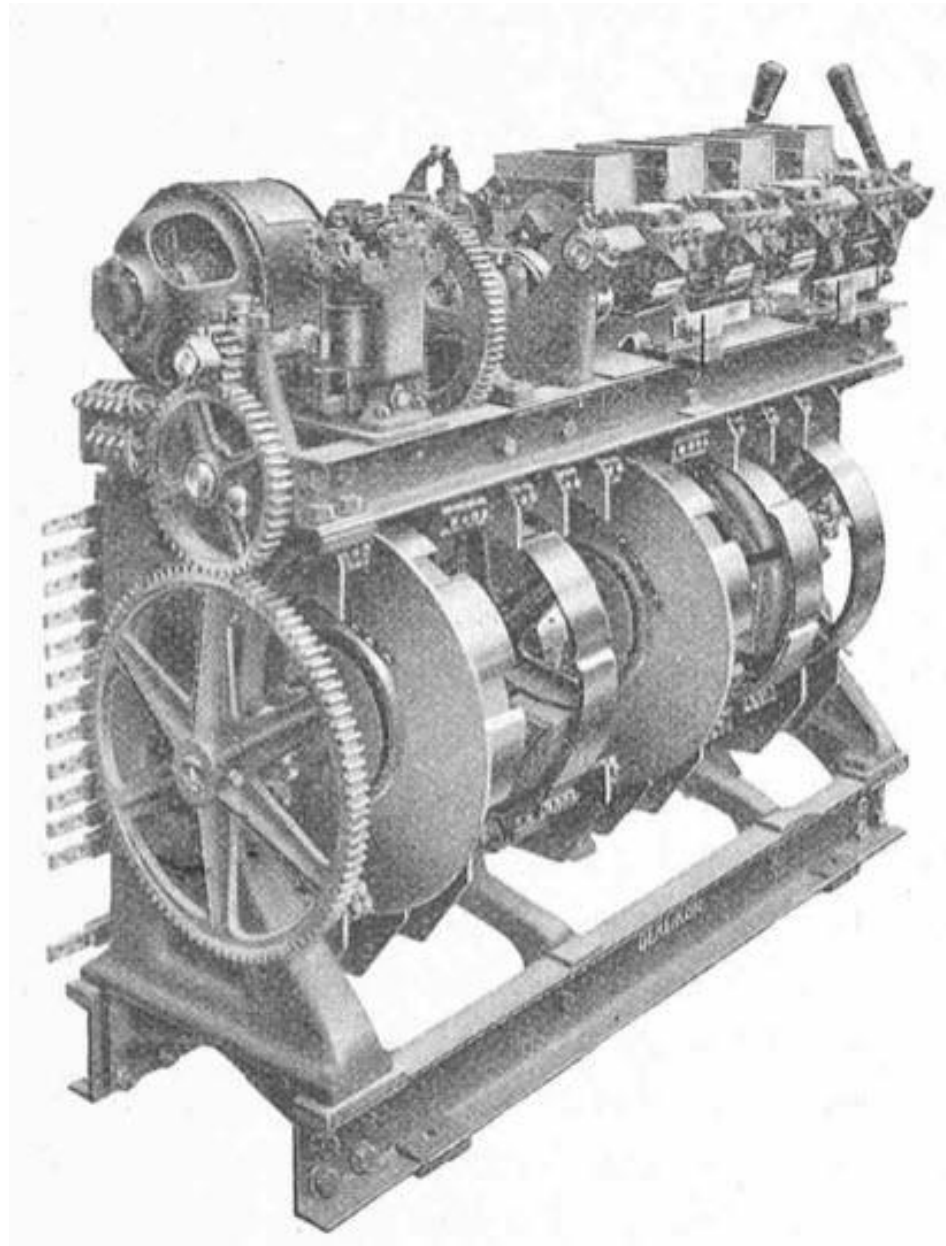
Main Oil  
Switch, lifted  
out of the  
case



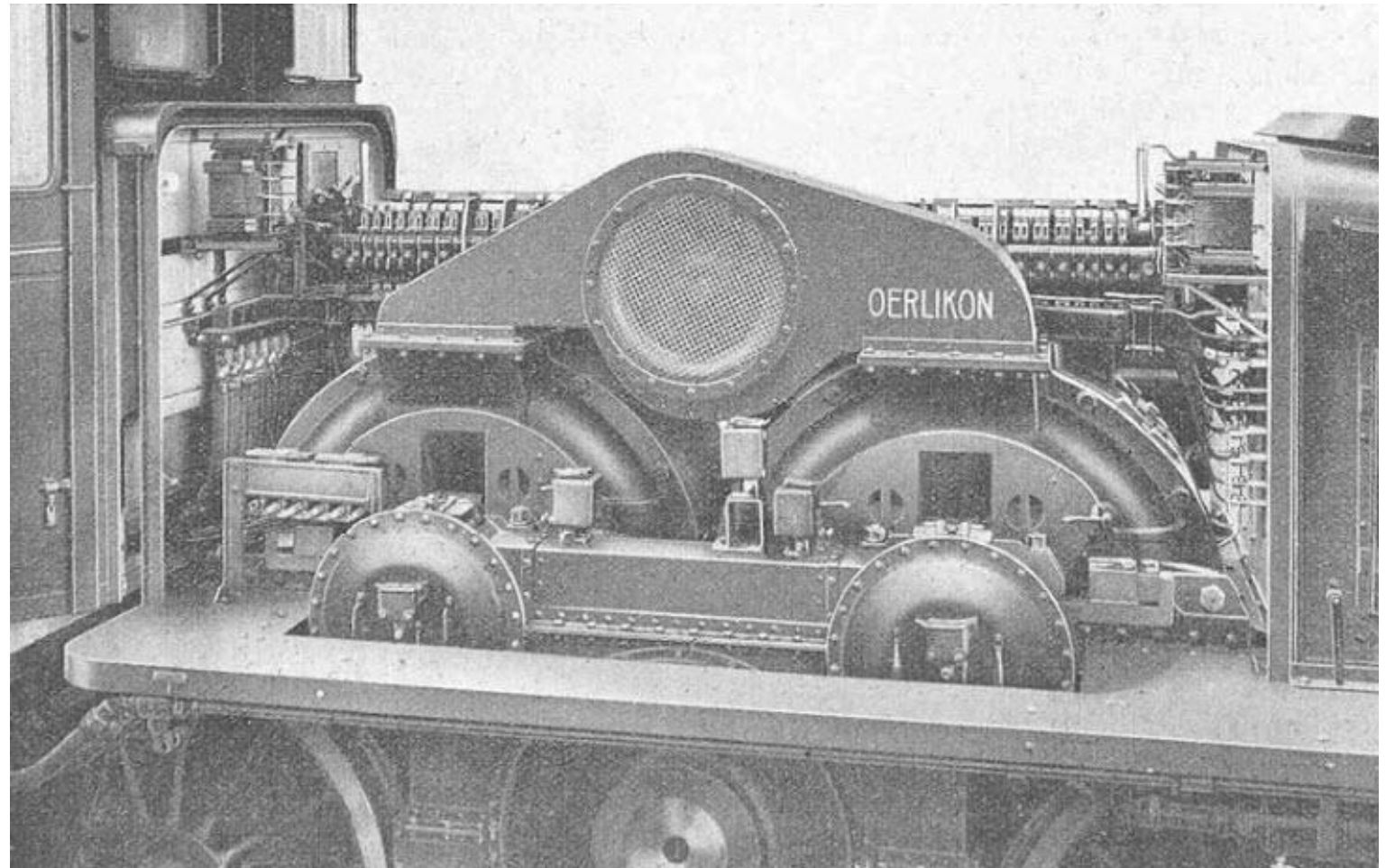
Step switch  
with contact  
lever



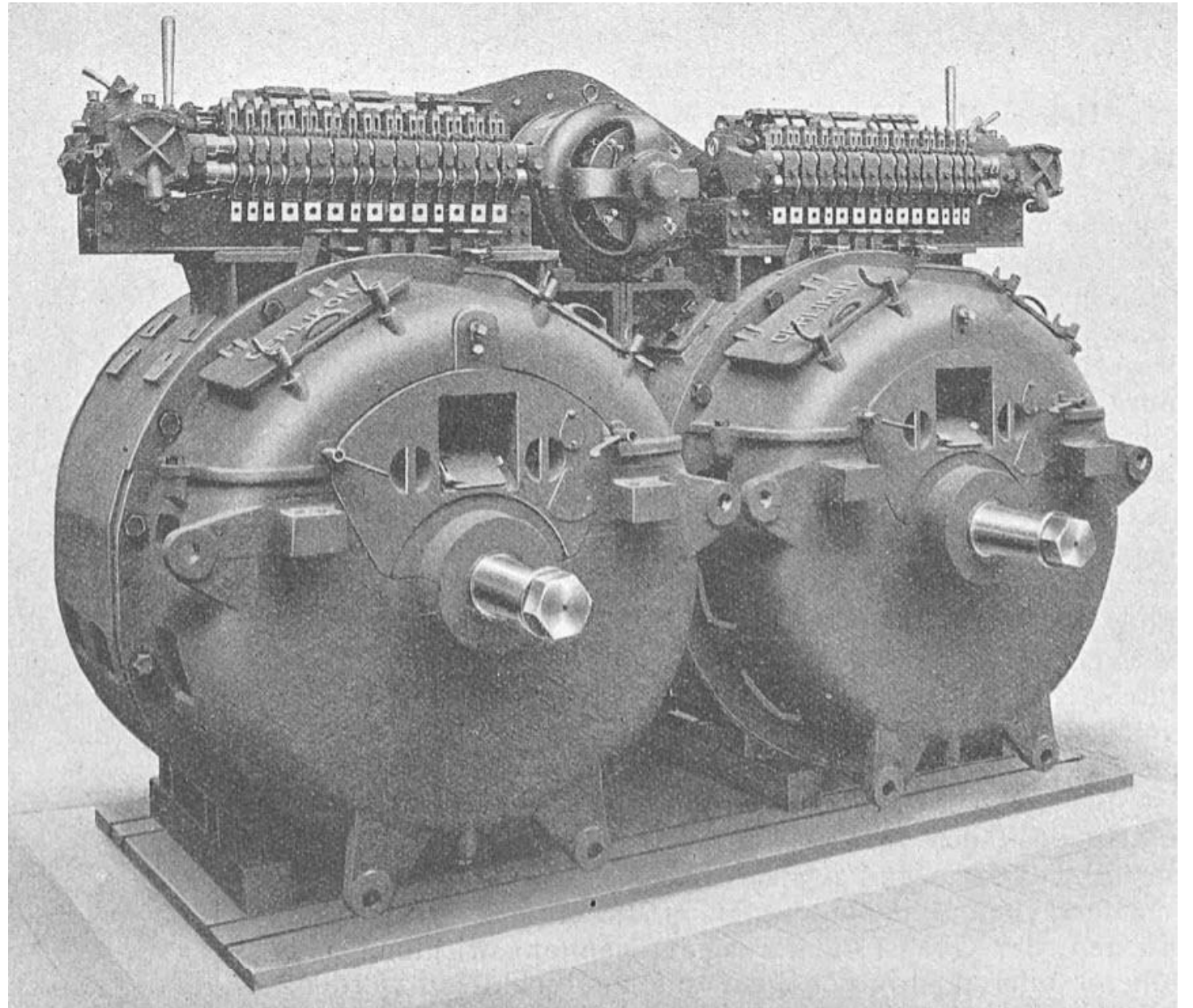
Step switch  
as a roller  
switch  
driven by a  
servo motor



Installed  
traction motor  
group with fan  
and mounted  
reversing  
switches



Traction motor group, removed  
(seen from the other side)

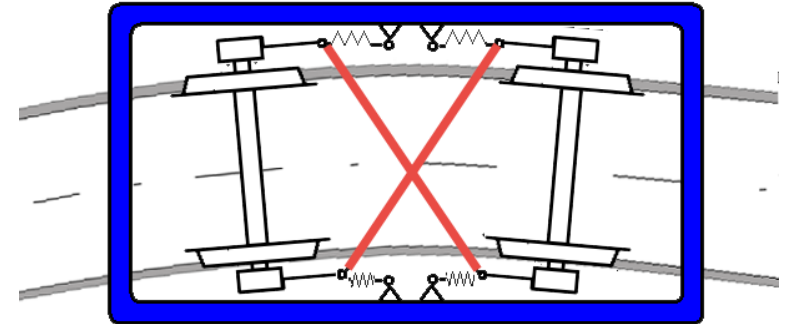


Switch of an  
accident  
damaged Ce  
6/8<sup>ii</sup>  
locomotive



# “Kreuzanker” – Cross Anchor Design

- To handle the sharp curves of the Gotthard, Cross Coupling incorporated
- Kreuzanker (Cross coupling) (red) to steer axles within a bogie can also be applied between linked motor frames (blue)




# Innovative Braking

SBB requested equipped with early form of regenerative braking from MFO



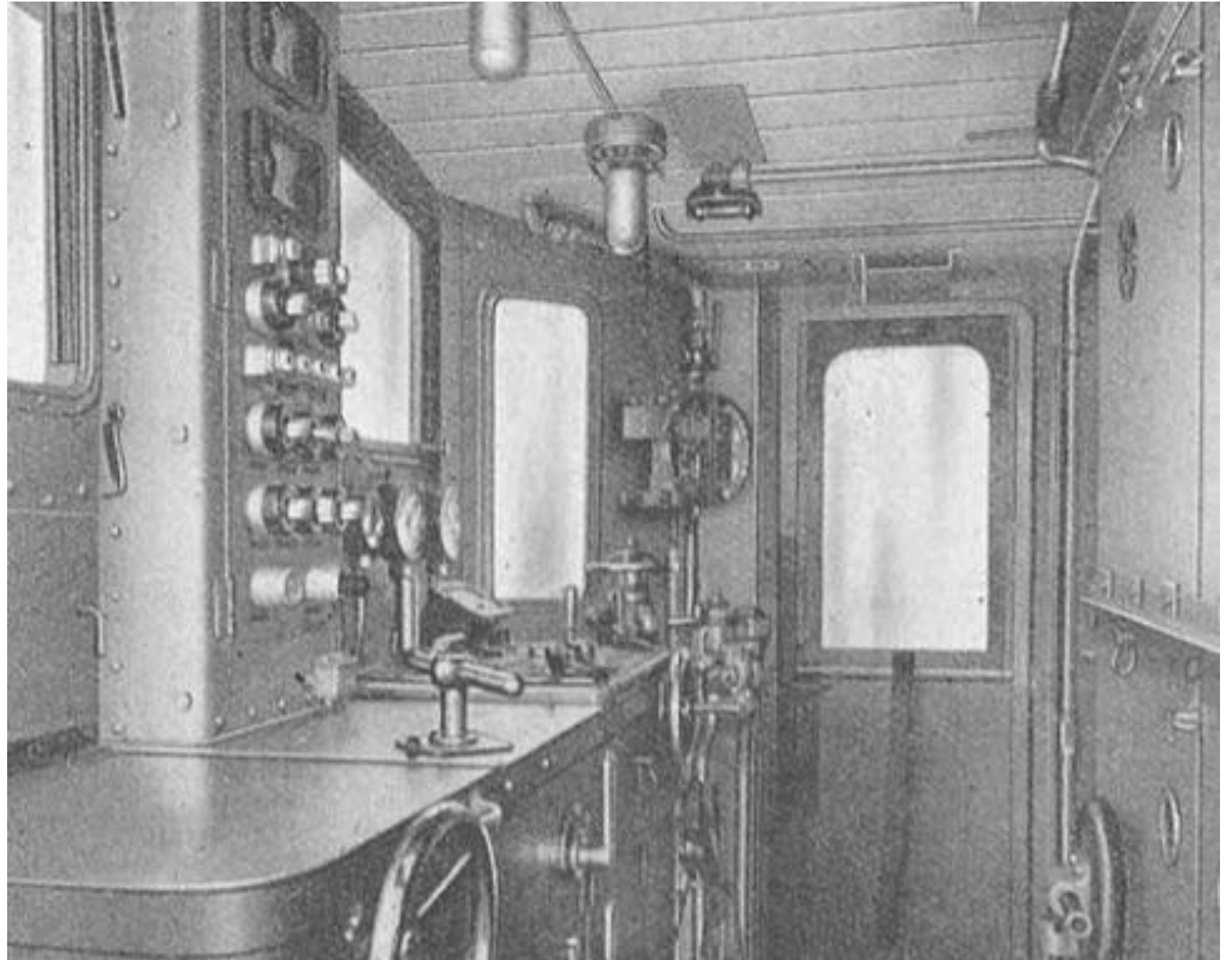
Sufficient energy was recovered on a falling gradient to brake the locomotive



Drivers would normally brake the locomotive with the electric brake and train with the air brakes

Crew operated standing

## Driving Cab – Interior View



# Driving Cabs

Laid out for two crew members

Work from a standing position

Relatively small front windows

Small window into bonnet so crew could check by sight, sound or smell all well with motors

Heaters & foot warmers provided

SBB allocated drivers to locomotives to encourage greater care

A hold over from steam practice days

# A Third Series (Second Generation)

Due to the success of the first series and the rapid network electrification, SBB ordered a second series from SLM & MFO

From experience gained, SLM/MFO increased hourly rating from 1640 kW to 1800 kW

Capable of hauling 520 tonnes drawbar @

- 30 km/h over 2.6% & 35 km/h on 1% gradients

Maximum speed increased from 65 km/h to 75 km/h

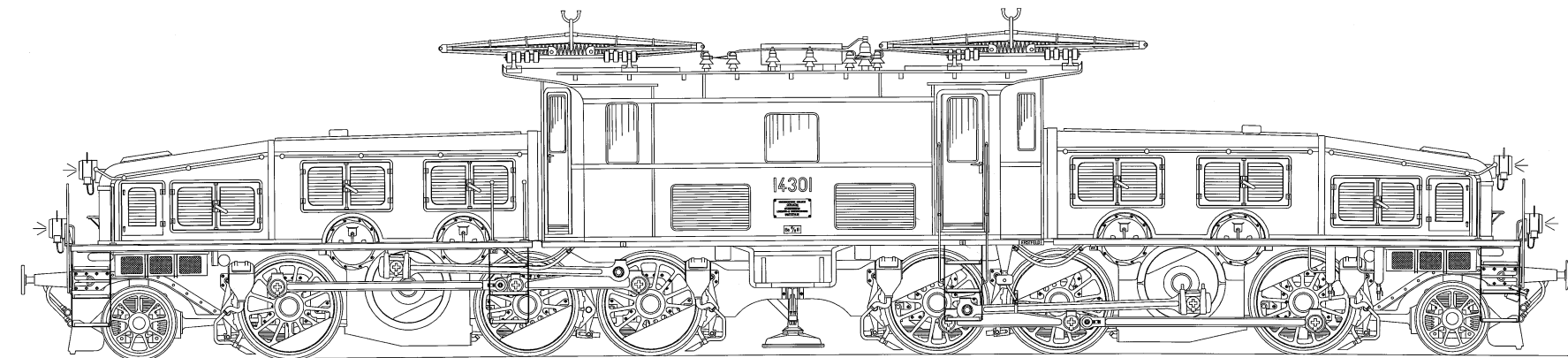
Between 1926 – 1927 18 machines entered service as 14301-14318

Became known as Ce 6/8<sup>iii</sup> and later Be 6/8<sup>iii</sup>

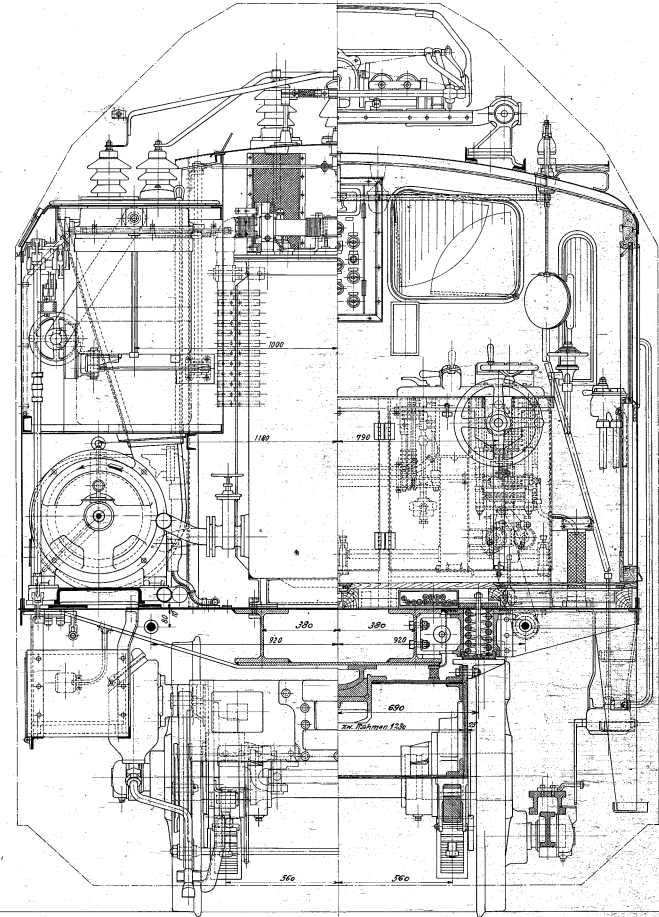
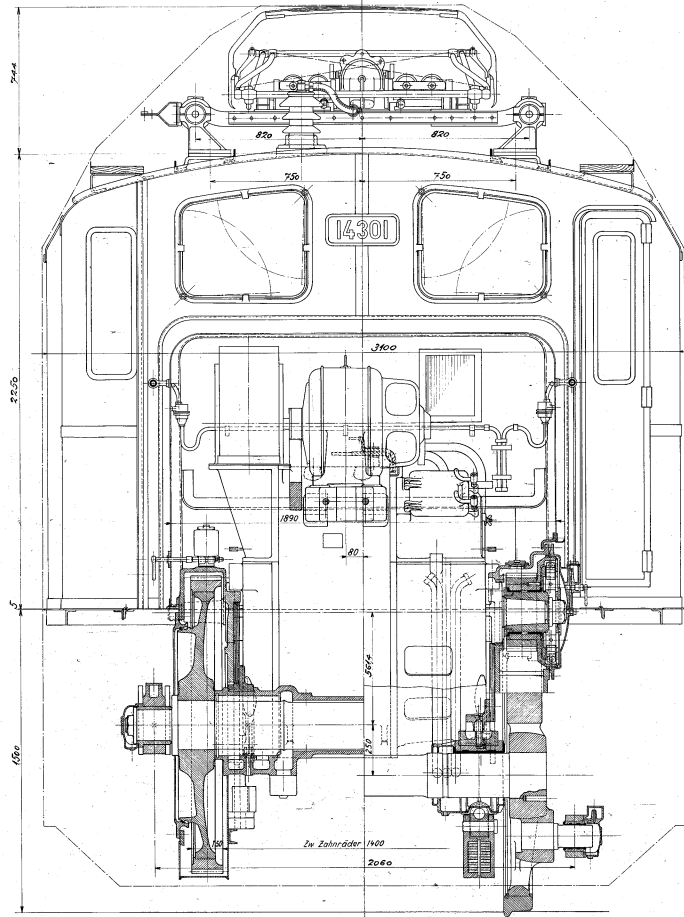
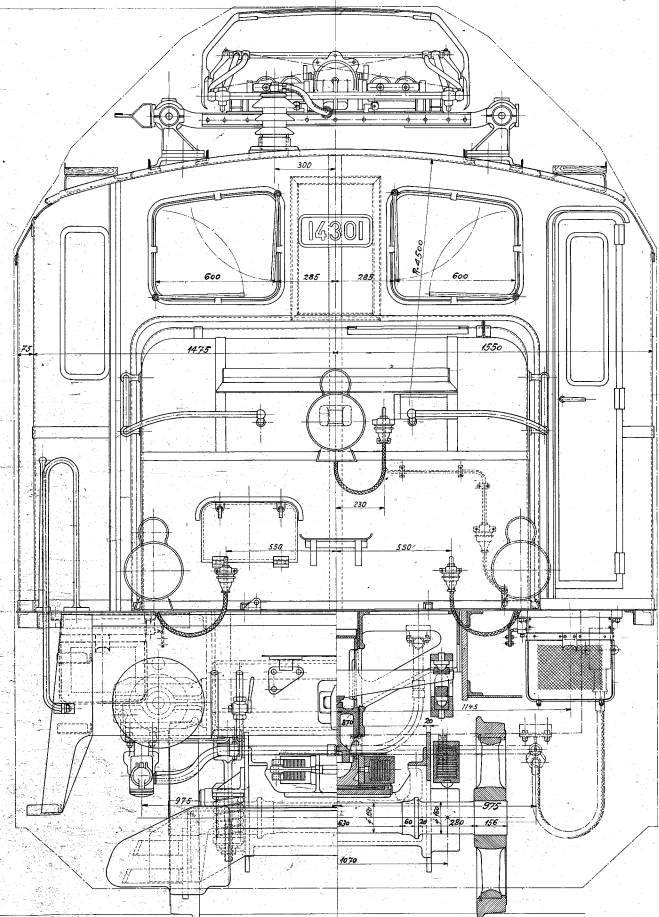
Ironically less powerful than those Ce 6/8<sup>ii</sup> rebuilt as Be 6/8<sup>ii</sup>

SBB Lokomotive Typ Ce 6/8 III

SBB Lokomotive Typ Be 6/8 III



	Ce 6/8 III	14301 -	Be 6/8 III	13 301 -
Erbauer:	SLM, MFO	Höchstgeschwindigkeit: 65km/h	Höchstgeschwindigkeit: 75km/h	
Baujahr:	1926-27	Triebrad ø: 1350mm	Triebrad ø: 1350mm	
Dienstgewicht:	131t	Laufgrad ø: 950mm	Laufgrad ø: 950mm	
Stundenleistung am Rad:	2460PS	Länge über Puffer: 20060mm	Länge über Puffer: 20060mm	



Spurweite	1435 mm
Totale Länge über Puffer	20060 mm
Totaler Radstand	17000 mm
Radler Radstand pro Träggestell	4700 mm
Triebrad Durchmesser	1350 mm
Lauf rad Durchmesser	950 mm
Zahnradübersetzung	1:4,027
Fahrdrahtspannung	1500 Volt
Frequenz	16 2/3

**Legende**

Dauerleistung am Radumfang	3200 PS
Geschwindigkeit bei Dauerleistung	39 km/h
Zugkraft bei Dauerleistung	15200 kg
Stundenleistung am Radumfang	2500 PS
Geschwindigkeit bei Stundenleistung	35 km/h
Zugkraft bei Stundenleistung	19300 kg
Max. Leistung (1/4 Stunde, n=35 km/h)	2680 PS
Max. Zugkraft	29000 kg
Max. Geschwindigkeit	65 km/h

**Legende**

Gewicht des elektrischen Teiles inkl. Stromabnehmer, Kompressor etc.	
Gewicht des mechanischen Teiles inkl. Nostinghaushaltbremse	76,65 t
Gewicht der Ausrüstung	
Dienstgewicht der Lokomotive	
Adhäsionsgewicht	

Maschinenfabrik Oerlikon  
Zschg. No. 133838  
Schweizerische Lokomotiv- & Maschinenfabrik Winterthur  
Zsch. No. L 30028

9	1435	SBB Ce 5/6	L 5725
9	1435	SBB Ce 5/6	L 5715
Zur Ordnung gehörende Positionen			Blatt 802
SBB elektr. Lokomotive Ce 5/6 1-C-C-1			
1:10 Zusammenstellung Querschnitte			
Schweizerische Lokomotiv- und Maschinenfabrik Winterthur. Zsch. L 30028			

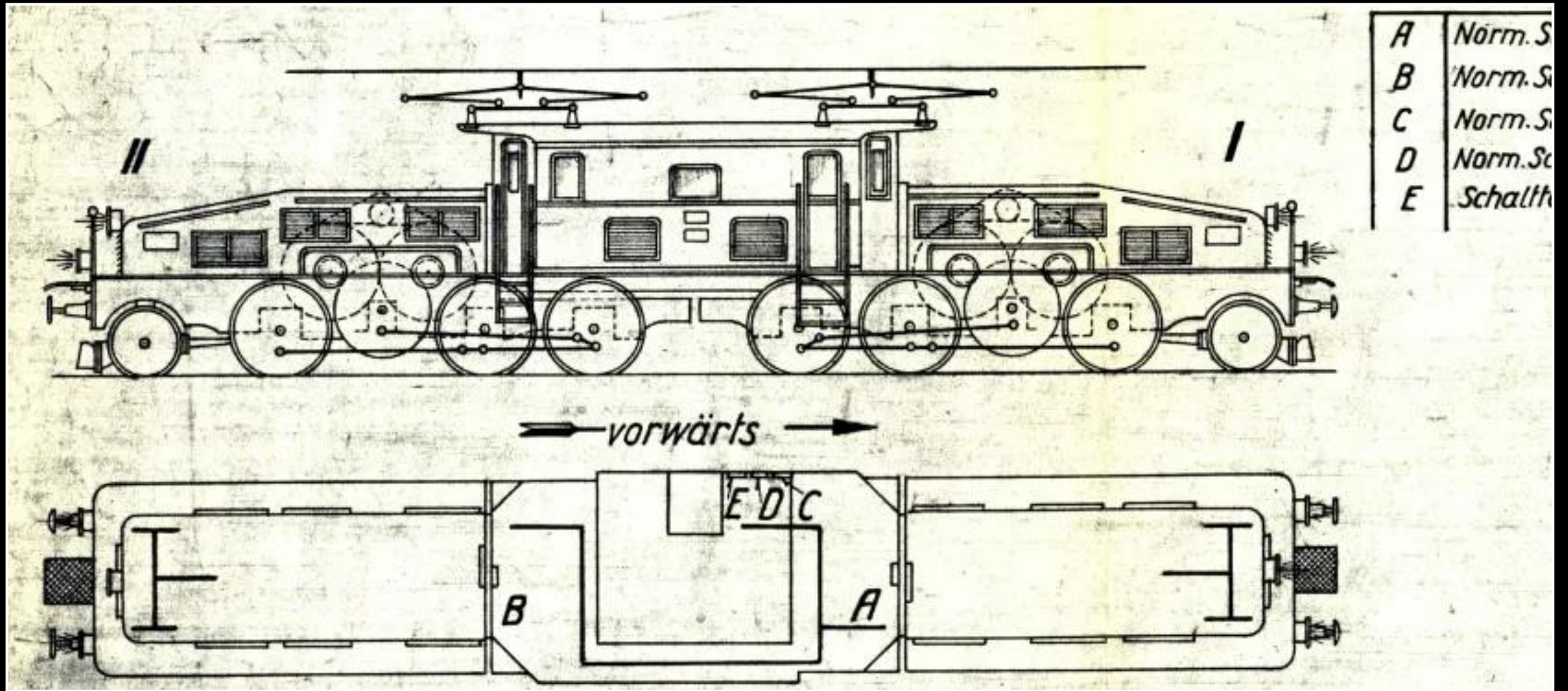
Verkleinert auf 1:20

# Ce 6/8ii > Ce 6/8iii Coupling Rod Change

CE 6/8<sup>iii</sup>'s power was transmitted to the rear driving axel in each powered bogie then by connecting rods to the other axels

By contrast, Ce 6/8<sup>ii</sup> power went to the leading axel in the first instance, then by coupling rods to the other axels

Reports indicated Be/Ce 6/8<sup>ii</sup>'s were quieter



Crocodile Ce 6/8<sup>iii</sup>

Rod drive with  
triangular frame.  
Jackshaft on the left,  
dead-shaft on the right.

Ce 6/8<sup>ii</sup> power  
went to the  
leading axel in the  
first instance,  
then by coupling  
rods to the other  
axels



Ce 6/8<sup>ii</sup>



Ce 6/8<sup>iii</sup>



# Rebuild of Ce 6/8<sup>ii</sup> to Be 6/8<sup>ii</sup>

Heavy usage took its toll - traction motors and failures in service

MFO proposed modernizing motors that increased hourly power rating from 1640 kW to 2700 kW

SLM updated mechanical parts, springs and strengthened frame

Additional buffer beams added

Be 6/8<sup>ii</sup>  
#13254 in the  
Swiss  
Museum of  
Transport



Rebuild of Ce  
6/8<sup>ii</sup> to Be  
6/8<sup>ii</sup>

13 locomotives rebuilt 1942 – 1947

60mm longer but 2 tonnes lighter!

Top speed from 65 km/h to 75  
km/h hence change from Ce to Be

	Be 6/8 II (13 251)	Be 6/8 III (13 302)
Operador	SBB/CFF/FFS	SBB/CFF/FFS
Año de construcción	1920 - 1921	1926 - 1927
Constructores	SLM y MFO	SLM y MFO
Vía	Standard	Standard
Tensión alimentación	15 kV a 16,67 Hz	15 kV a 16,67 Hz
Longitud	19460 mm	20060 mm
Distancia entre ejes	16500 mm	17000 mm
Distancia entre ejes (morro)	6700 mm	6650 mm
Distancia entre pantógrafos	5450 mm	5500 mm
Diámetro rueda	1350 mm	1350 mm
Diámetro rueda maestra	950 mm	950 mm
Carga por eje	17000 - 17600 kg.	16400 kg - 18800 kg
Factor transmisión	1:4.03	1:4.03
Número de motores	4, tipo conmutador de una fase	4, tipo conmutador de una fase
Peso	126000 kg	130900 kg
Peso, tractor	103000 kg	108400 kg
Potencia arranque máxima	30,000 kg	30,000 kg
Potencia continua tracción	21,840 kg a 45 km/h	19,000 kg a 35 km/h
Potencia media p/hora	3650 hp (2721 kW) a 45 km/h	2460 hp (1834 kW) a 35 km/h
Potencia media p/hora, transmisión	4 x 705 kW a 45 km/h	4 x 490 kW a 35 km/h
Potencia media p/hora, a las ruedas	3320 hp (2475 kW) a 46,5 km/h	2200 hp (1640 kW) a 38 km/h
Potencia continua en la transmisión	4 x 645 kW a 46,5 km/h	4 x 440 kW a 38 km/h
Velocidad máxima	75 km/h	75 km/h

SLM = Schweizerische Lokomotiv- und Maschinenfabrik (Winterthur) · MFO = Maschinenfabrik Oerlikon.

Wheels in  
Motion –  
14253 @  
Wassen





Erstfeld September 2025







Be 6/8<sup>ii</sup> 13256 Gravel Train 1973



Be 6/8<sup>ii</sup> 13256 crossing Rhine 1975

Be 6/8<sup>ii</sup>  
13256 at  
Eglisau 1975



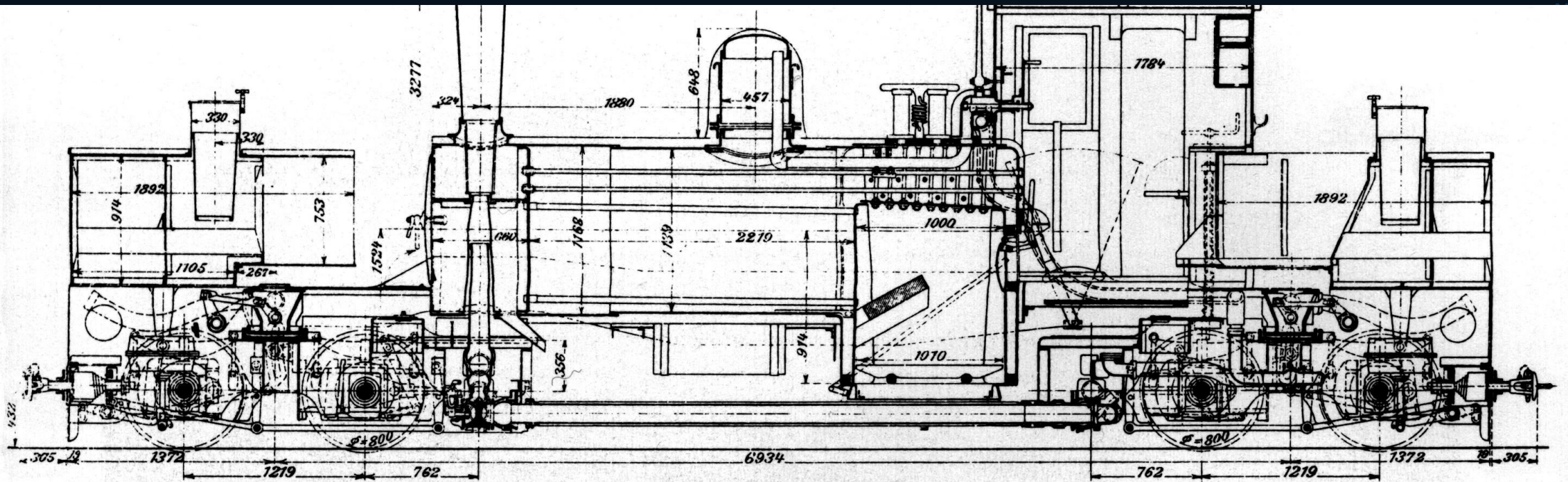
# Winterthur Depot September 17, 1978

- Be 4/6 12320, already painted in brown
- Green Be 6/8<sup>II</sup> 13255 and 13256



Be 6/8<sup>ii</sup>  
13257 near  
Glattfelden  
1975





Crocodile's 'seen'  
as an electric  
Beyer-Garratt!

- Main transformer and control gear where the boiler would be
- Motors in place of the cylinders and driving wheels

# Withdrawals

- 1952 – 1966 Ae 6/6s began arriving
- Ce 6/8<sup>ii</sup> saw lighter duties including as shunters
- Be 6/8<sup>iii</sup> not relegated to yard shunting
- Ce/Be 6/8<sup>iii</sup>s began to be withdrawn
- 1967 - First withdrawal #13318
- 1977 - Last withdrawal #13305



Sad ending for some ... but not all is lost!

# Seven Ce 6/8<sup>ii</sup> Preserved

---

14253 (brown) operational at SBB Historic

---

14254 (green) being refurbished at SBB Historic

---

13257 (green) in the [Südbahnmuseum](#) in [Mürzzuschlag](#)

---

14267 (brown) in the [Technikmuseum Speyer](#)

---

14270 (green) since 15 June 2020, a covered open-air monument in Zurich-Oerlikon

---

14276 (green) at the [Club del San Gottardo](#), operational refurbishment planned

---

14282 (green) at the [Auto- und Technikmuseum Sinsheim](#)

---

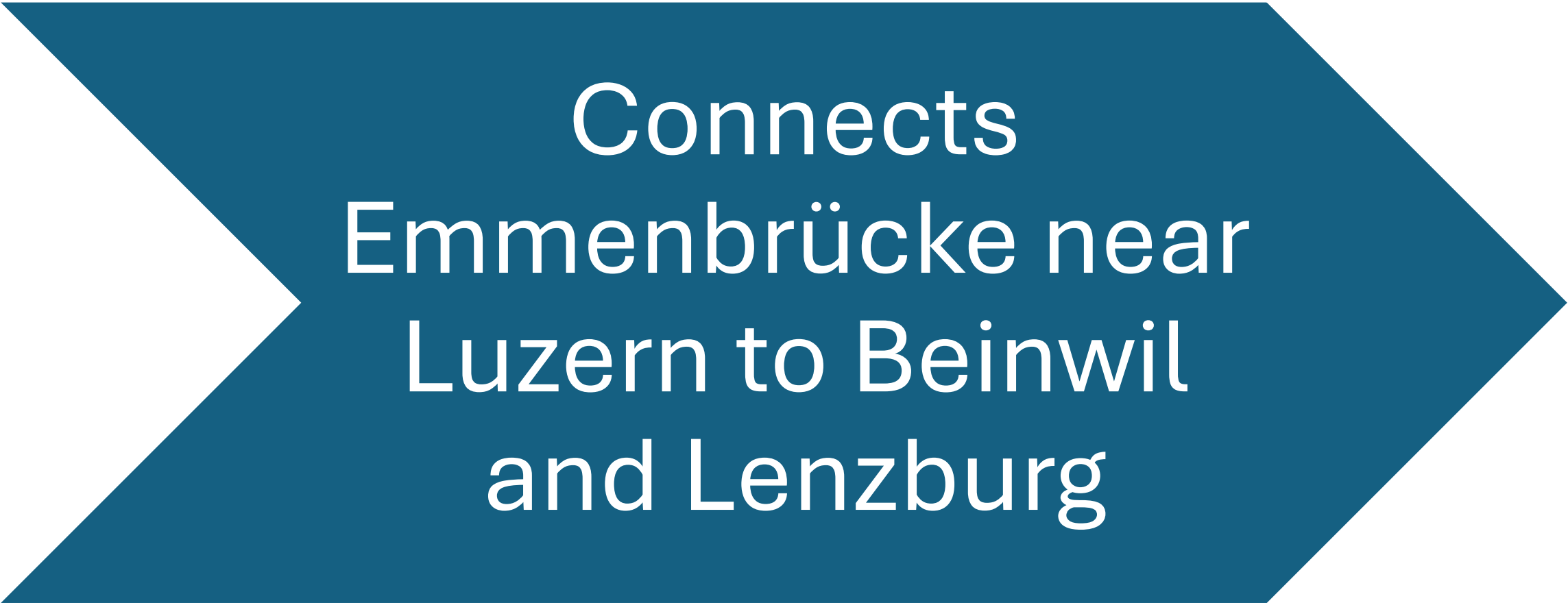
Source Wikipedia

# Two Ce 6/8<sup>iii</sup> Preserved

13305 preserved  
by SBB Historic  
as 14305 in  
working order

13302 preserved  
working by  
Modelleisenbahn  
Club Horgen

And now for an “Independent”! Seetalbahn



Connects  
Emmenbrücke near  
Luzern to Beinwil  
and Lenzburg



Proximity of road & rail

# Seetalbahn

1909 the Seetalbahn  
electrified with non-  
standard 5.5 kV 50  
Hz

1922 passed to the  
SBB

SBB identified the  
need for dual-voltage  
freight locomotives  
to work this route

# Requirement for new locomotives

1926 saw the purchase of three new locomotives

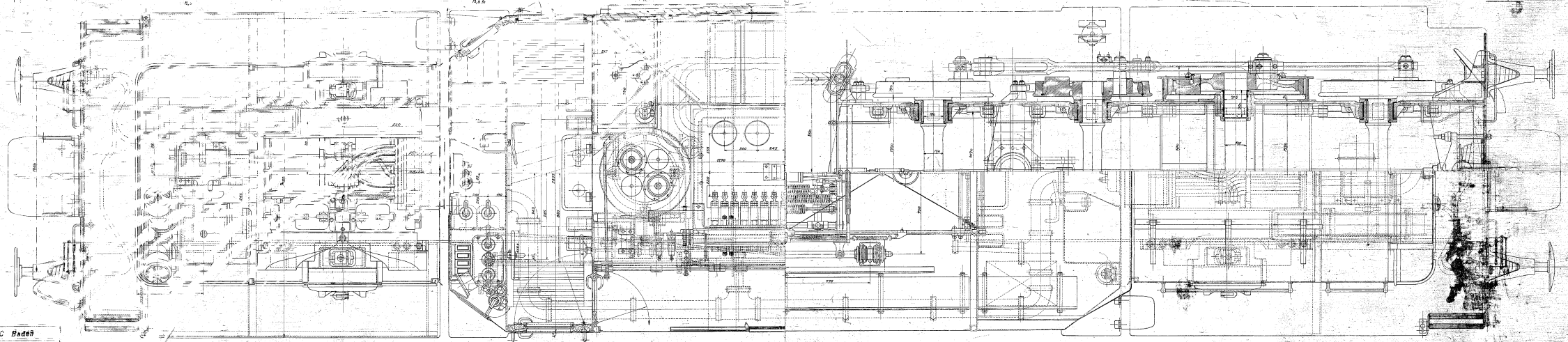
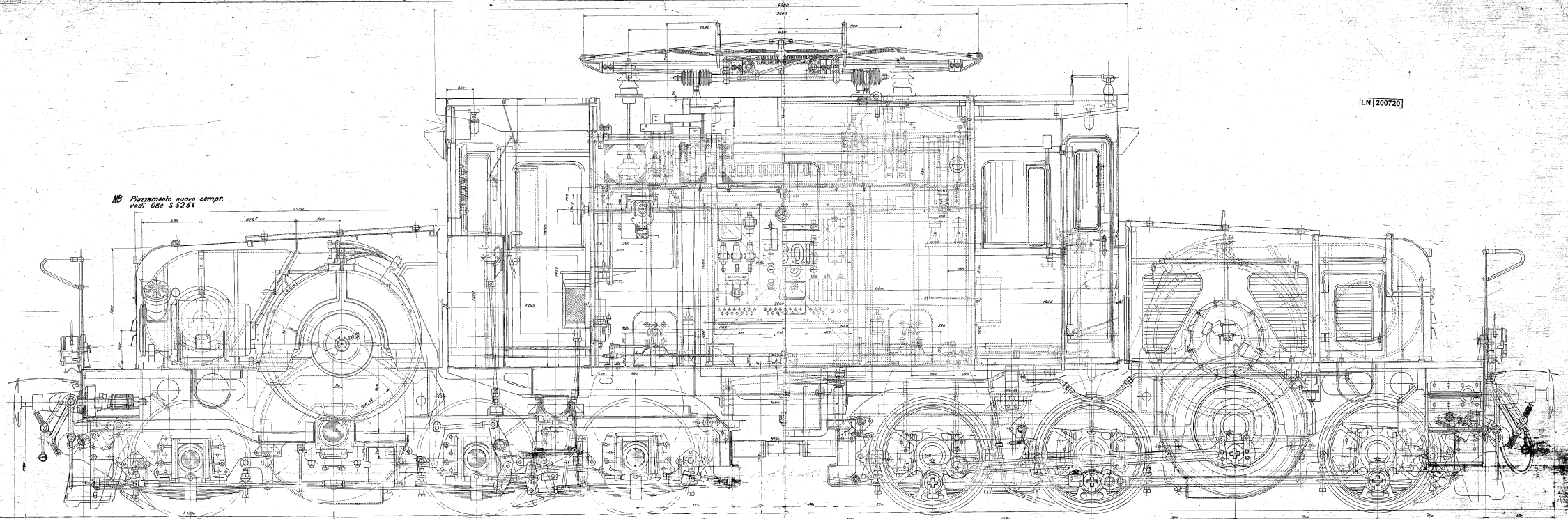
Built by SLM BBC

The specification required

- 5.5 kV 50 Hz
- Planned change to 15 kV 16 <sup>2/3</sup> Hz
- Operate on sharp curves (route then included road running)
- Maximum 12 metric tonnes axel loading
- Haul 200 metric tonnes on a 3.6% grade
- Max speed 50 km/h (31 mph)
- Power output 850 kW (1.14 k/hp)

LN 200720

NB Puzamento nuovo compr.  
vezi 08e 5 5256



BBC Baden

B 432251

1:1

1:1

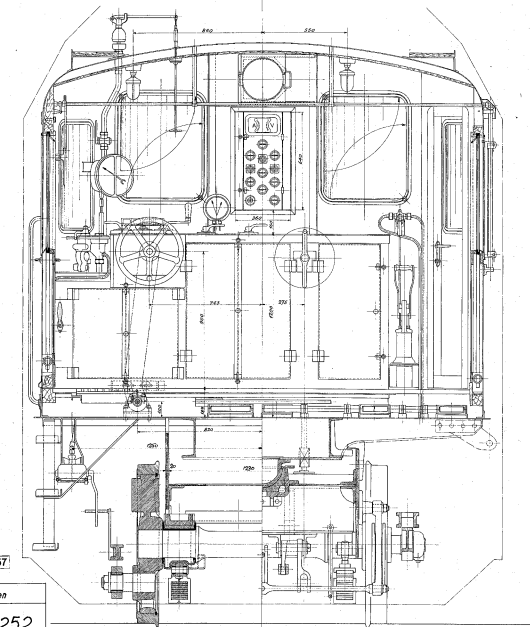
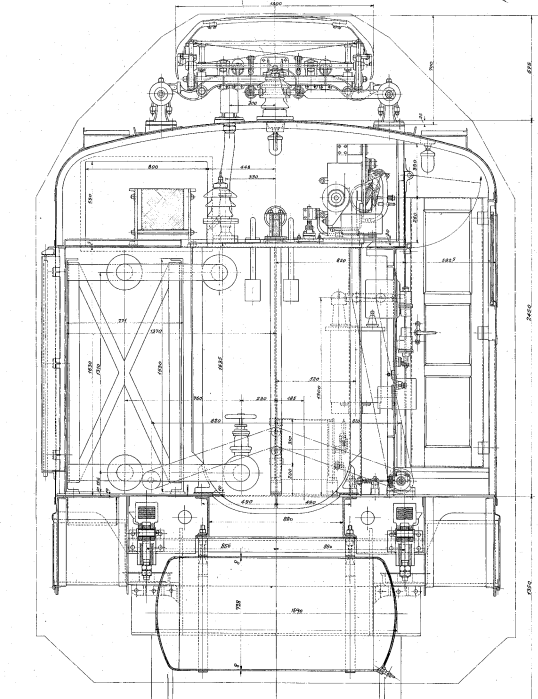
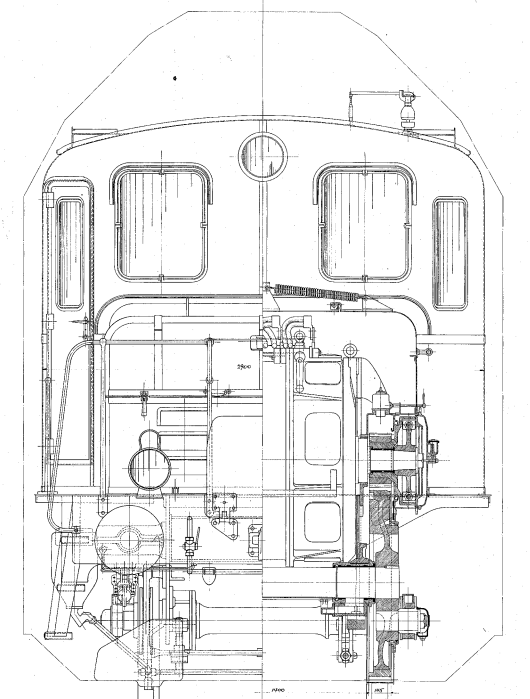
1:1

1:1

1:1

L. 29300

0.15728: 300



— S.B.B. Seetalbahn. —  
Elektrische Lokomotive De  $\frac{6}{6}$ [C-C]

— Legende —

<b>Elektrische Schalttafel</b>		<b>Abwärmeschieber</b>	
Leuchtapparat (nach Reichsbahn)	1100 / 1100 F	Druckbremse in der Lok	1000 kg
Heizvorrichtung	649 / 25	Wärmehaube (Druckbremse)	1500 kg
<b>Mechanische Schalttafel</b>		Wärmehaube (für Steuer)	1500 kg
Spindel	1000 kg	Komplett Steuertrieb	202 kg
Teile Länge über Räder	1000 kg	Komplett Steuertrieb	100 kg
Teile Restlauf	1000 kg	Komplett Zugtrieb (Stromerzeugung)	10000 kg
Teile Restlauf	1000 kg	Komplett Zugtrieb	10000 kg
Teile Restlauf	1000 kg		
Teile Restlauf	1000 kg		
Teile Restlauf	1000 kg		

— Gewicht —

Gewicht des nach Teile	1000 kg
Gewicht des abstr. Teile (mit Kompressor)	2500 kg
<b>Teilegewicht</b>	720 kg
<b>PS-Motorgewicht</b>	720 kg

Konstruktion: S.B.B.

Konstruktion: S.B.B.

LN 201257

SBC Baden

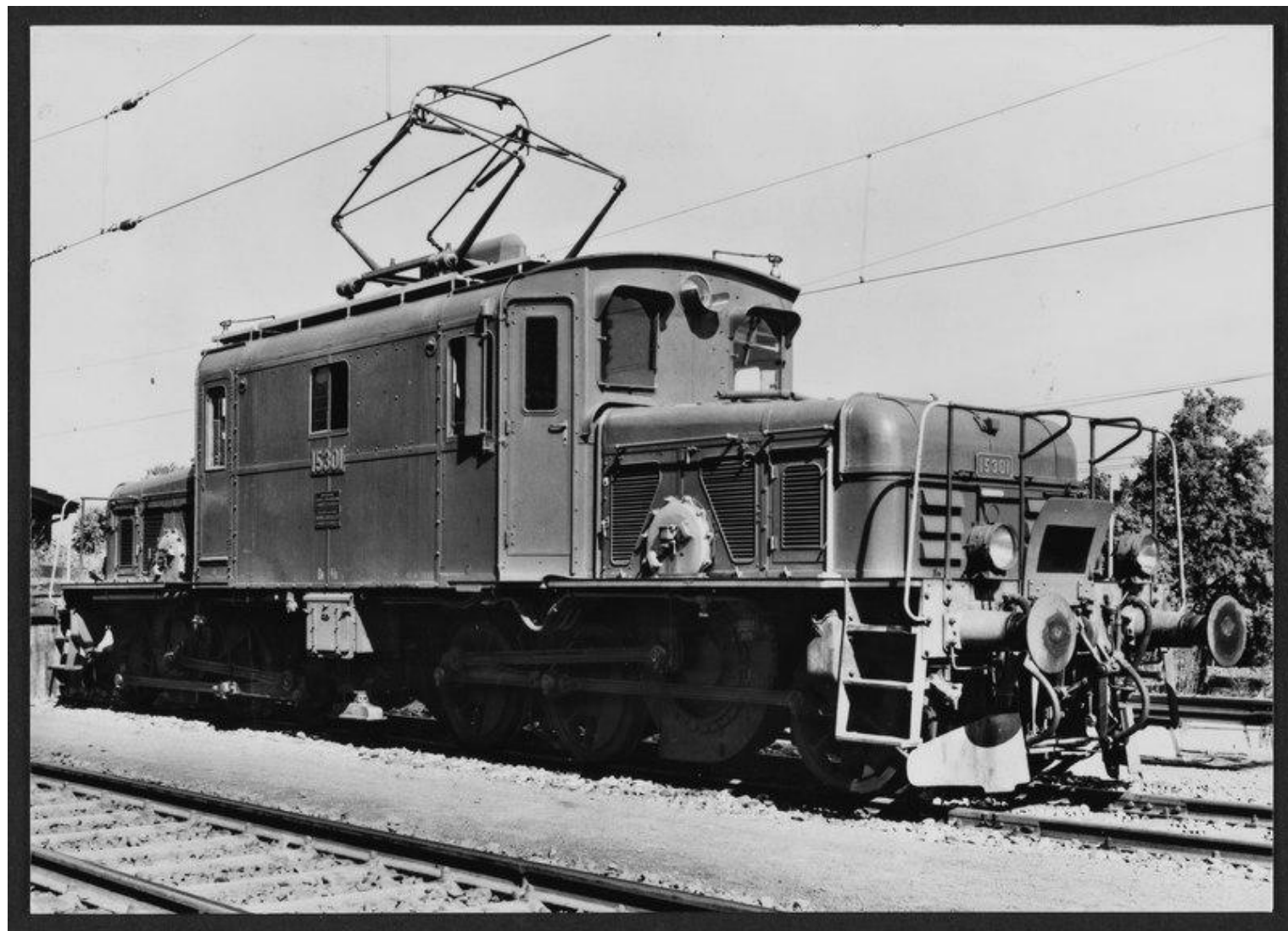
B 432252

Elektrische Lokomotive

Zsch. L. 29301

2203  
O.L. 5728 Bl. n° 801.

Seetal  
Crocodile -  
De 6/6



Seetal  
Crocodile -  
De 6/6

---

C'C' wheel arrangement, weight 73 tonnes

---

Became known as the "Seetal Crocodile" due similarity to Ce 6/8

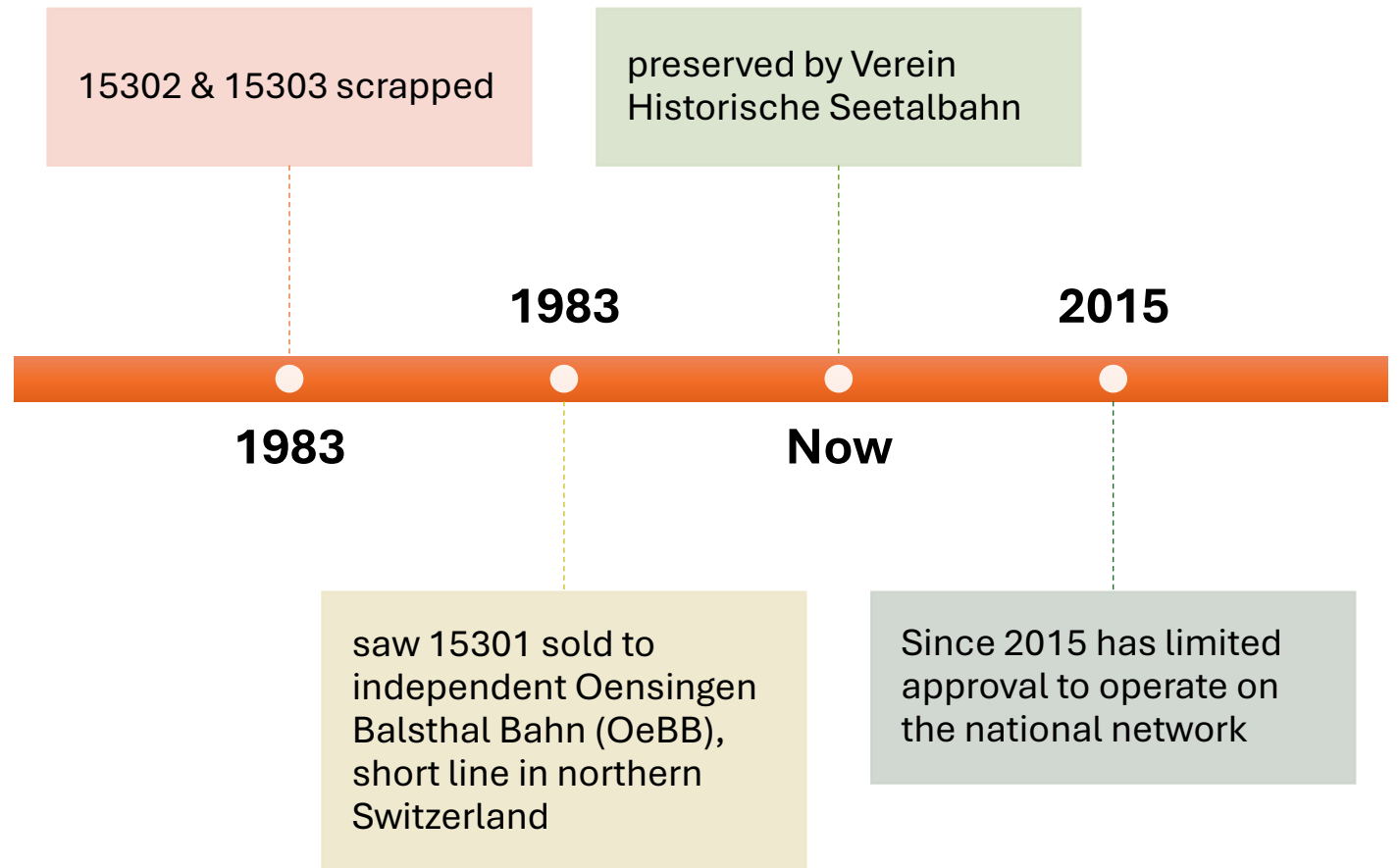
---

Based in Luzern, allocated 15301 – 15303

---

1930 line converted to 15 kV 16<sup>2/3</sup> Hz

# Seetal Crocodile - De 6/6 15301



Crocodiles  
are not the  
sole preserve  
of Standard  
Gauge in  
Switzerland!



# Metre Gauge Crocodiles

---

Crocodile examples were found on:

---

Rhaetian Railway (RhB) operates in the largest Canton Graubünden in the south-east of CH

---

The RhB is adhesion throughout with maximum gradients of 7%

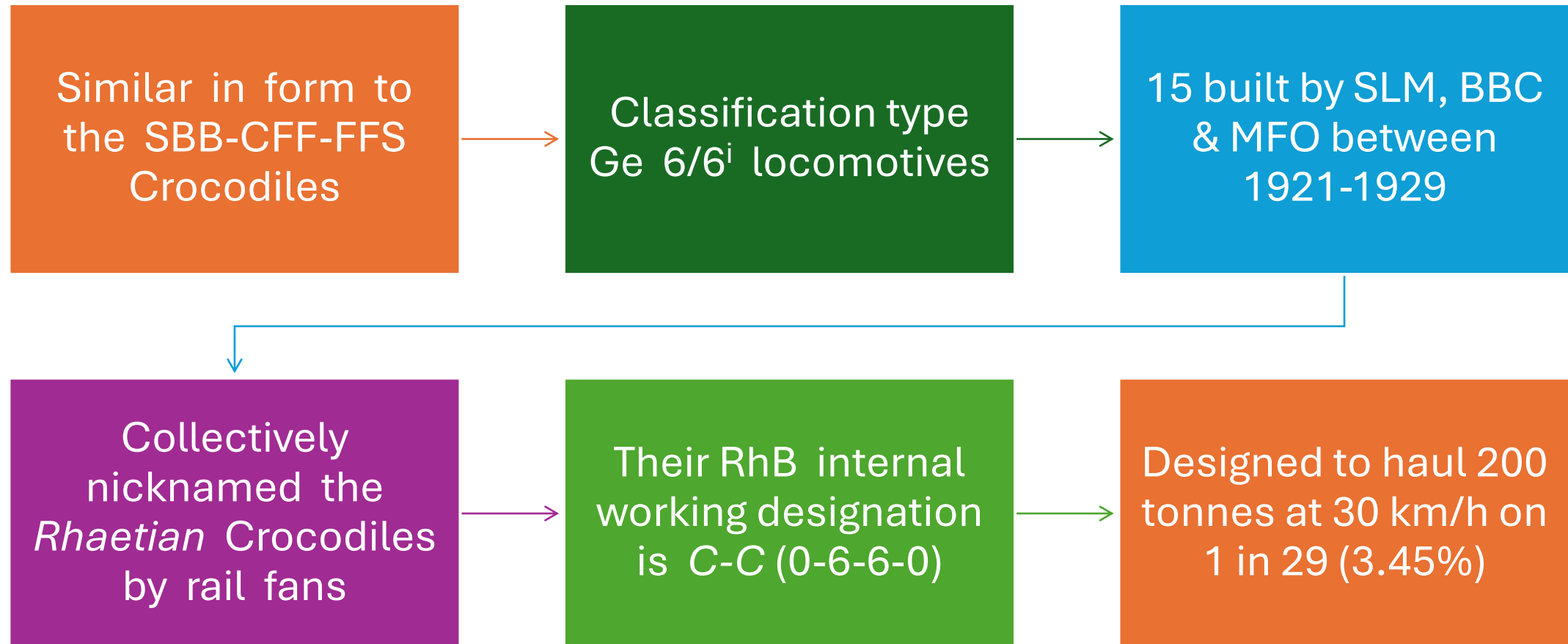
---

Brig Visp Zermatt (BVZ) later merged with the Furka Oberalp (FO) to become the Matterhorn Gotthard Bahn (MGB)

---

The MGB is rack assisted using the Abt system

# RhB Crocodile



# RhB Crocodile

As with its standard-gauge counterpart, articulated with a gear-driven Jackshaft between the two end axles of each unit connected to the drive wheels by side rods

Two 600 hp 500V series motors with rheostat connections

Drove jackshafts by rods to the inner coupled axels

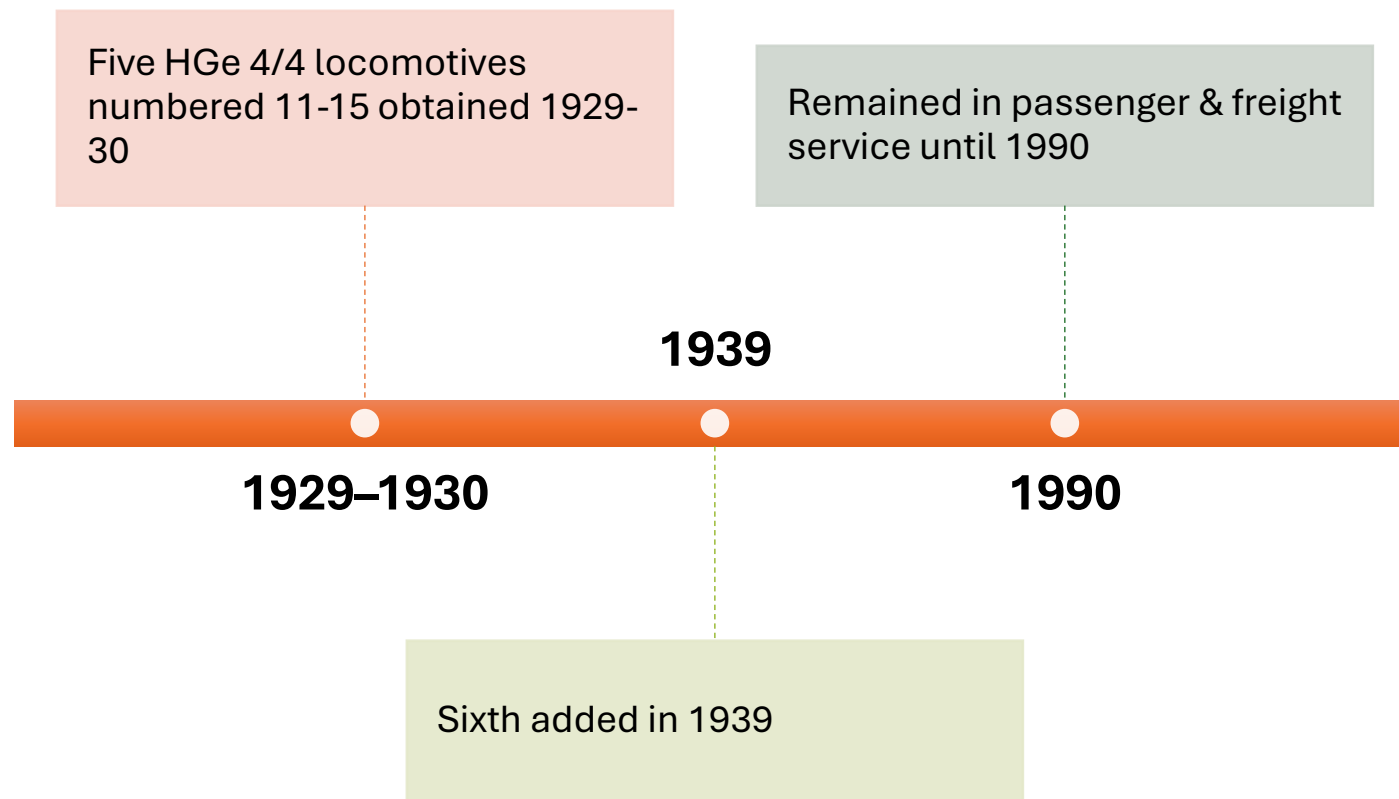
Vacuum brake supplemented with resistive electrical braking

RhB maintain 414 & 415 serviceable for special trains

RhB Ge 6/6<sup>i</sup>



# BVZ Crocodiles



# BVZ Crocodiles

Similar in appearance to RhB's Crocodiles with significant differences

- Smaller bogies
- Absence of rod drive
- Rack equipped
- Central part of body had two cabs either side of the transformer and small luggage area

No 15 & 16 have been preserved in care of MGB-Historic

BVZ  
Crocodile

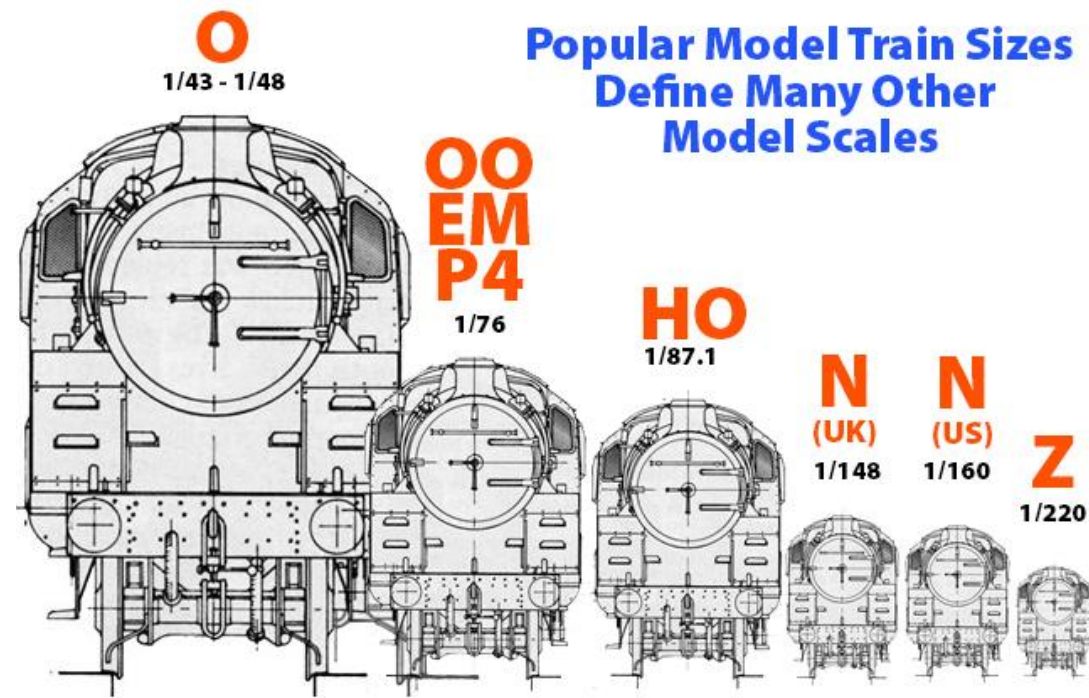


# Crocodiles were not unique to Switzerland

- Countries include
  - Austria - Classes 1089 & 1189 “Austrian Crocodiles”
  - Germany - Classes E.93 & E.94 “Alligators”
  - India - Class WCG-1
  - France - Classes CC 14000 & CC 14100 “Flatirons”
  - Panama - “Mules”
  - Spain - “Cocodrilo”
- “Crocodile-like” countries include
  - Georgia – Borjomi–Bakuriani railway
  - United Kingdom – LNER Class ES1
  - United States – Milwaukee Road EP-2 “Bi-Polars”

# For the modelling enthusiast .....

- Products produced by number of modeling companies in a variety of scales Z, N, TT, HOm, HO, 1, through G. These include
  - Bemo
  - Fleischmann
  - Ferro-Suisse
  - Fulgurex
  - Lego
  - Märklin
  - Piko
  - Roco
  - Trix



Be 4/6 -  
Marklin HO #  
39510



Be 4/6 -  
Marklin HO #  
39520



Fc 2x3/4  
“Kofferlilok”  
– Marklin HO  
# 39520



Ce 6/8<sup>iii</sup>  
Marklin 1  
Scale 55681



Seetal HO  
Scale  
Crocodile  
Trix HO  
22246/Marklin  
37521



# BVZ & RhB Models available in HOm & G

**Bemo HOm (BVZ & RhB)**



**LGB G (RhB)**



# Helpful Resources

## European Train Enthusiasts

- [www.ete.org](http://www.ete.org) Colonials Chapter

## Swiss Railways Society

- [www.swissrailsoc.org.uk](http://www.swissrailsoc.org.uk)

Swiss Railways Society  
[www.swissrailsoc.org.uk](http://www.swissrailsoc.org.uk)



European Train  
Enthusiasts

[www.ete.org](http://www.ete.org)

Colonials Chapter



## Acknowledgements

- LCTM Lista de Correo de Trenes Märklin
  - [https://www.lctm.info/Secciones/Trenes/LocoMes/GRR\\_Be68/index.php](https://www.lctm.info/Secciones/Trenes/LocoMes/GRR_Be68/index.php)
- Øyvind Teig
  - <https://www.teigfam.net/oyvind/home/oyvind-teig/>
- Swiss Electric Locomotives since 1900 by Martin Fisher
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- Swiss Express, Journal of the Swiss Railways Society ([www.swissrailsoc.org.uk](http://www.swissrailsoc.org.uk))
  - SE #139 Crocodile Centenary Part 1 September 2019 Bill Salter
  - SE #140 Crocodile Centenary Part 2 December 2019 Bill Salter
  - SE #150 Crocodiles at Hüntwagen-Wil June 2022 Bernhard Studer
- Wikipedia
- William Salter

Questions?

Before we visit the displayed  
models .....



**This short film of amateur color footage taken at Bern HB 1962/3**

<https://www.youtube.com/watch?v=uylGFJE7MME>

# Thank you

Boyd Misstear

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March 21, 2026

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