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# THE ELECTRIC RAILWAY – PART 6

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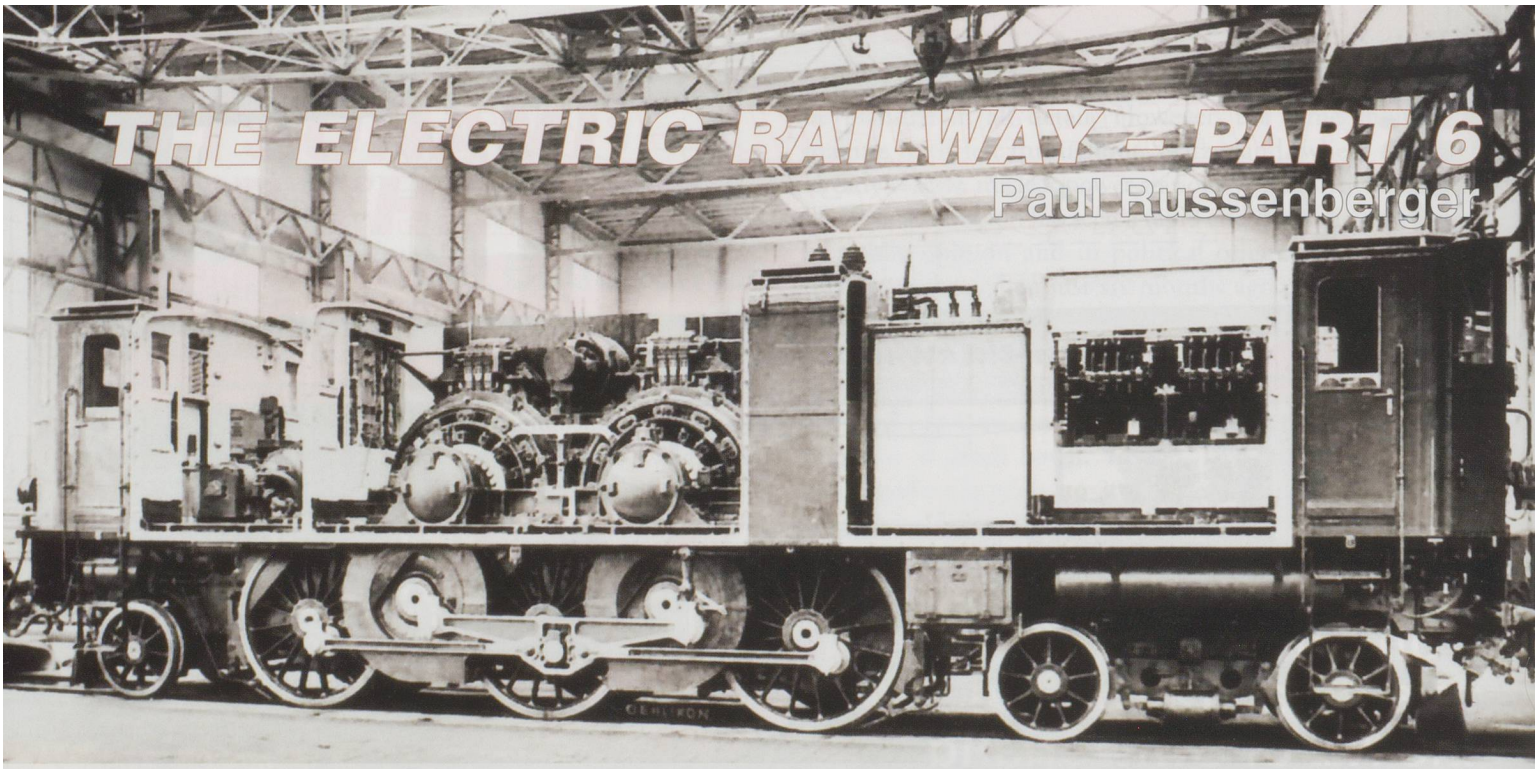

An Ae3/6 II opened up. PHOTO: Heinz Russenberger

## The Pre-War Mainline Locomotives

An initial assessment of the operating requirements of a fully electrified Swiss Federal Railways identified three regimes of duty, each of which would require its own type of locomotive:

- **Heavy freight trains**
- **Passenger trains on the Gotthard line**
- **Passenger trains on relatively level routes**

In 1917 the SBB ordered four experimental locomotives, giving the industry considerable freedom to meet the requirements already identified, though all were built by SLM. The rapid progress of the installation of the trackside equipment meant that the SBB had to place orders for production series of locomotives, before the prototypes had been thoroughly tested. The machines delivered all had large a.c. traction motors carried within the body, though on the bogie locomotives they were mounted on the bogies themselves. The voltage applied to the motors was controlled by altering the number of windings on the high voltage side of the transformers. Inevitably the mechanical concepts used in steam locomotives influenced the designs and all used a rod drive to transmit power from the motors to the driving wheels. As well as enabling large motors to be accommodated, it reduced any tendency the locomotives might have to slip – a particularly useful feature in a locomotive used on steeply graded lines. Each locomotive remained in use until the 1960s.

Oerlikon supplied electrical equipment for a 1C1, Be3/5 No 12201 weighing 93t and had an hourly power rating of 1600hp, and a 1B-B1, Be4/6 No 12301. This was heavier at 107t and could deliver 2320 hp hourly. Brown Boveri equipment came on a 1B-B1, Be4/6 No 12302 weighing 107t but only rated at 1920 hp hourly, and a 1C-C1, Ce6/8I No 14201, the heaviest of all at 118t and also the most powerful, rated at 2370hp, though its maximum speed was 65 km/hr as opposed to 75 km/hr. The Be4/6 was the prototype of the well known class of which a further 40 appeared between 1920 and 1923 to work passenger trains on the Gotthard route. The production series were rather more powerful at 2040 hp and could haul trains of 300t at 50 km/hr on the steepest gradients.

Although the original Ce6/8I had a conventional box body carried on two large bogies, it was developed into the first classic 'crocodile' class Ce6/8II, of which 33 examples numbered from 14251, and rated at 2240 hp, were delivered in 1921 and 1922. A further series of class Ce6/8III Nos. 14301-18 appeared 5 years later, rated at 2460 hp. Their weights varied between 128 and 131t. The crocodile is essentially an electric version of the Beyer-Garratt. The transformer and cabs are carried in the centre section which is supported at each end by large bogies, each of them carrying two motors and other equipment in the 'bonnets', which are low enough not to impede the driver's line of sight. The mechanical drive of the Ce6/8III used the jackshaft of the prototype, though the Ce/68II used a yoke rod, driven from the motors at the inner end and supported on another layshaft immediately behind the pony truck. All these locomotives were fitted with regenerative braking. On level track they could sustain a speed of 40 km/hr hauling 1200t and take 450t on the Gotthard at 36 km/hr. Between 1942 and 1947, 13 of the Ce6/8II were rebuilt and uprated to 3640 hp as class Be6/8II with a maximum speed of 75 km/hr, while the whole class of Ce6/8III were so treated from 1956. On rebuilding, 1000 was subtracted from the running numbers. Twelve of the un-rebuilt Ce6/8II were altered between 1965 and 1971 to make them suitable for use as marshalling yard shunters. They were not renumbered. Withdrawal began in 1965, mainline use ceasing in 1983 and yard use three years later.

The Seetal line received six lightweight C-C crocodiles in 1926. They weighed only 73t and developed 1170 hp. The C-C wheel arrangement contributed to the reduction in weight. The SBB then considered carrying axles to be necessary to ensure safe riding at the higher speeds achieved on the main line, but not required on the Seetal. They were withdrawn in 1983 – after over 55 years in service.

Sécheron supplied electrical equipment for six slightly larger 1Bo1-Bo1 locomotives built by SLM in 1922. Classified Be4/7 with a maximum speed of 80 km/hr, they weighed 111t, were rated at 2400 hp and numbered from 12501. Two motors powered each driving axle and were carried on the bogie. While the locomotives appeared symmetrical, the pivot points of the bogies were not. On the 1Bo1 bogie it was in the centre, but on the other bogie the body was supported immediately behind the cab, between the outer carrying and driven axles. The outer carrying axles were in pony trucks, while the middle carrying axle was mounted in the bogie without lateral movement. The class was not multiplied further though the last was not withdrawn until 1976. No 15204 has been preserved.

1921 saw the first appearance of what was to become a Swiss classic in the Ae3/6I. This was a 2Co1, rated at 1920 hp initially with a maximum speed of 100 km/hr and weighing 93t for use on the more easily graded routes. The motors were mounted in the body directly above the driving axles. To take up relative vertical movement between the body and the wheels, the motors drove the axles individually through Büchli drives, fitted outside the driving wheels on one side only. The size and position of the motors prevented the transformer being placed in the centre of the locomotive, so it was moved to a position behind the cab at the end with the two-axle bogie. The class eventually totalled 114 units numbered from 10601, construction continuing until 1929; those built after 1925 had a maximum permitted speed of 110 km/hr and were rated at 2100 hp. Five remain in preservation.

A larger version for use on the Gotthard, the 2Do1 Ae4/7, followed from 1927. Although rated at 3120 hp maximum speed was 100 km/hr. 127 examples were finally built up to 1934, numbered from 10901. Thirty were equipped with regenerative braking and 22 for multiple working. With the Ae3/6I they formed the mainstay of SBB passenger power into the 1960s. Twenty two have been preserved.

Two further versions of the Ae3/6 appeared in 1924 and 1925. The first (Ae3/6II, numbered 10401-60) carried two large motors coupled through an external yoke which then drove through coupling rods – almost an electric 'Pacific'! It could deliver 2000 hp and had a maximum speed of 100 km/hr. Built by SLM, Oerlikon supplied the electrical equipment. The whole class survived into the 1960s and 10439 has been preserved.

In 1922 the 26 class Ae3/5 began to enter service, with electrical components manufactured by Sécheron. Rated at 1800 hp for a weight of only 81t, the motors drove through a Westinghouse-Sécheron hollow axle drive. Each axle was driven by two motors whose pinions engaged with a gearwheel on a hollow axle surrounding the driving axle. This gearwheel was connected to the driving wheels through a set of springs which could accommodate the relative movement of the road wheels and the body. The maximum speed was 90 km/hr. The last nine were modified from 1963 to operate car carrying trains. Withdrawal took place over 15 years from 1967; one has been preserved. The final class of eleven Ae3/6III locomotives were a lengthened variant with a bogie in place of one pony truck. The power output and maximum speed were the same, though the weight was increased by 8 tonnes. Withdrawal occurred concurrently with the Ae3/5 and 10264 is in preservation.

An increase in freight traffic on the Gotthard in the late 1920s, caused the SBB to investigate the development of more powerful locomotives. One particular issue was the transport of coal to Italy which was being supplied as war reparations by Germany. This arrived at Basel in block trains of 1200t. SLM built a prototype twin unit Ae8/14 in1931. Developing 7000 hp and weighing 246 tonnes, it is essentially two Ae4/7s placed back-to-back with a transformer in the centre of each unit. A similar locomotive entered service the following year with an increased rating of 8250 hp. It differed in having the Büchli drives replaced by an additional gearwheel between each traction motor pinion and its driven axle gearwheel. A further unit appeared in 1940 rated at 11,100 hp. Unfortunately, the economic downturn of the 1930s rendered the units unnecessary by the time the first two entered service. The first locomotive has survived as a historic locomotive at Erstfeld and the last is in the Verkehrshaus. At the outbreak of the Second World War, the total fleet of SBB steam locomotives had been reduced to 411 from over 1200 and the SBB was well stocked with some 440 mainline electric locomotives. The objective of mitigating the effect of reduced coal supplies during hostilities had been achieved. However, the electric fleet had been built very much in the steam idiom with robust mainframes carried on large driving wheels. The first Leichtstahlwagen were in use and under series construction. Changes were coming and developments were to take place in Switzerland of international significance.

BELOW: Ae4/7 10925 in Zurich in Aug 1974.

BOTTOM: Be4/6 12320 at Interlaken West in August 1988.
PHOTOS: Paul Russenberger