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Some Swiss Locomotives for the SNCF.

by Paul Russenberger

Switzerland is not renowned as an exporter of locomotives. However, both France and Britain have made use of Swiss machines as prototypes. This article tells the story of two locomotives from SLM that ran for two decades in normal service on the SNCF – the French National Railways.

In the years following the end of the Second World War, the SNCF began to look beyond the immediate prospect of the Paris – Lyon electrification towards the possibilities of regular running at 160 kph. The 2-Do-2 locomotives then in use and on order were mechanically the cousins of the SBB Ae4/7. They were clearly unsuitable for the speeds envisaged. Their weight would have led to an unnecessary amount of energy being expended in maintaining that speed and there must have been doubts about the forces which would have been applied to the track by a rigid framed locomotive running at that speed. (All SNCF eight-coupled steam locomotives had maximum permitted speeds of more than 120 kph.)

It was also becoming apparent that the future of electric locomotive development lay in total adhesion machines in which all axles were driven. In England, the LNER had produced a single Bo-Bo in 6701, later to become the BR 26000 "Tommy", as the mainstay of the Manchester – Sheffield/Wath scheme. Like the then current SNCF electric locomotives, "Tommy" took direct current at 1500V.

Although 6201 was running successfully in Holland, its maximum speed of 120 kph was lower than that envisaged for future SNCF passenger work. Its continuous rating of 1868 hp was inadequate for the weight of French trains and its own weight of nearly 88 tons was excessive. This partly arose from its construction using a separate underframe to carry the body which was not load bearing.

In Germany the E44 Bo-Bo had been in service since 1931. Although at 78 tonnes it was adequately light, its power output and maximum speed were both inferior to the SNCF BB-8100. In any event, it would have been politically very difficult to use German technology at that time.

In Switzerland, the Bern Lötschberg Simplon had introduced their Ae4/4 Bo-Bo with a power rating of 4260 hp for an overall weight of 80 tonnes in 1944. These were soon followed by the Swiss Federal Railways Re4/4 (later Re4/4 I) in 1946, with an hourly rating of 2450 hp but weighing a mere 57 tonnes. They were intended for use on trains made up of lightweight, integrally constructed coaches running on the relatively flat route between Zürich and Geneva, while the BLS locomotives were for use over the 1 in 40 ruling gradient of the Spiez to Brig line.

The BLS machines had a maximum speed of 110 kph while the SBB ones were capable of 125 kph. In each case the significant weight reduction over the British locomotive was achieved by using integral construction to build the strength of the locomotive into the body itself. Both were, of course, ac machines.

Thus the various technologies that the SNCF sought existed, but not yet in a single design.

The SNCF Division des Etudes de Traction Electrique (DETE) approached the Swiss Locomotive Company (SLM) and a French consortium, Materiel de Traction Electrique (MTE), made up of Societe des Forges et Acieries du Creusot, Jeumont, Schneider-Westinghouse and Oerlikon. They developed a specification for four-axle locomotives with fully suspended traction motors able to operate the same diagrams as the 2-D-2 9100 class. Their aim was to achieve a continuous power output of 4000 – 4600 hp for a weight of 80 tonnes with an initial maximum speed of 140 kph, capable of being raised to 160 kph. The BLS Ae 4/4 had shown that these aspirations were achievable, at least in so far as weight and power were concerned; while the SBB Re 4/4 showed that higher speeds were likely to be achievable.

Orders for two pairs of 1500 V dc prototypes were placed with SLM in Switzerland and MTE in France, to be numbered BB 9001/2 and BB 9003/4 respectively. BB9001 and 9002 were delivered in June and December 1953. Together with the French built locomotives, they went to Paris Charolais depot whence they operated intensive diagrams of fast trains between Paris and Lyon. These were later eased to include slower, heavy, night trains such as the "Train Bleu".

The Swiss locomotives were built at the SLM works in Winterthur with the electrical equipment supplied by Brown Boveri of Baden. The bogies and suspension followed the then

current Swiss practice. The body rested on two transverse girders, outer ends of each one rested on two longitudinal, inverted leaf springs on the outside of the bogies; these were hung from and below the bogie frame. This in turn rested on eight coil springs, one on each side of each axlebox, controlled by friction dampers. (The inverted leaf spring arrangement is similar to that used on the British Class 71 and 74 locomotives.) The bogie pivot passed though the girder to engage with another girder, which was part of the bogie frame, at the same level as the leaf spring buckles. This achieved a very low point of contact between the body and bogies. Small rods adjacent to the leaf springs transmitted traction forces between the bogie and body.

The bogie frames were fabricated from rolled steel with smaller components cast. Inside the coil springs resting on the axleboxes, steel tubes acted on silentblocs which were attached to bronze tubes, inside which cylindrical steel guides attached to the bogie frame moved vertically, thus transmitting the traction forces to the bogie. This arrangement resulted in minimal play and was not found to require significant attention in service. (It is similar to that used on the British B4 trailer bogie.) The axles were permitted +/- 8 mm of play, against springs, relative to the bogie frame.

To reduce pitching and weight transfer between axles, the bogies were linked elastically through extensions rigidly attached to the inner ends of the bogie frames. As weight was transferred onto, say, the inner axle of the leading bogie, and thus also onto the outer axle of the trailing one, the trailing bogie, which would take some of the transferred weight and reduce the transfer from the leading axle, would support the leading bogie. This would also sustain the weight resting on its inner axle. The traction motors were fully suspended, torque being transmitted through two Brown Boveri elastic discs to the motor pinion which followed the axle mounted gear wheel, a method already proven in Belgium and Switzerland. In this mechanism, the first disc is driven by the motor, the drive shaft being attached by two radial lines of screws lying on the same diameter. The disc drives a second shaft, attached in a similar way, but at right angles to the first line of screws. This arrangement is repeated through another disc which drives the pinion wheel meshing with the gear wheel on the wheelset. The discs are placed on each side of the motor, the armature axle being hollow to contain the shaft connecting the discs. The relative movement between the fully suspended motor and the road wheel is achieved through the discs themselves flexing; the attraction of this system is the lack of linkages that would be subject to wear.

The four traction motors carried 6 poles and were fully compensated with 6 auxiliary poles to assist commutation. The brush gear was particularly robust and, since each motor was capable of operating continuously at 1800 volts, this was particularly necessary, since nine stages of field weakening to a maximum reduction 76% were provided. Under these conditions a dc series motor can be prone to "flash-overs", a short circuit occurring between adjacent brush-boxes along the commutator segments. The armature windings were insulated using mica and silk.

The motors could only be configured in series-parallel or all parallel as these locomotives were conceived for express passenger work. The traction resistances were mounted centrally in a single frame, together with the electrically driven controlling camshafts, the whole designed to be lifted out through the roof as a single unit. The resistances themselves were nickel-chrome strips, corrugated to assist the forced cooling. The equipment was placed along the centre line of the locomotive, two corridors on each side connected the cabs and gave easy access for maintenance. The pantographs and main circuit breaker were standard French items.

The buffing and draw-gear were carried on the all welded bodies which were distinctly Swiss. While the cab ends were raked back at an angle to be repeated on the SBB Ae6/6 and Re 4/4 II, the sides resembled the BLS Ae4/4. At waist level a chrome band separated the two tones of green originally carried and was carried forward to form a "moustache" on the fronts, the point reaching down to the level of the draw-hook.. Two headlights and marker lights, together with a number plate carried above and separate from the SNCF monogram also adorned the fronts. The two tone livery was later replaced with the lighter, blue tinged green during the` 1960s.

In July 1958 both locomotives were transferred to Montrouge to work on the Paris Montparnasse – Le Mans line until late August 1965 when they returned to Villeneuve where they survived until the early 1970s. BB 9002 was put into "attente d'amortisation" (AA), an SNCF classification for a locomotive which is not longer

in use and not intended to be returned to service, in April 1971, to be withdrawn in February 1972. BB 9001 went into AA in August 1972, being finally withdrawn in January 1973.

Since these were a pair of otherwise unique prototypes which had been joined by series produced machines, this length of service is a commendable commentary on their effectiveness. Neither the Swiss nor the French prototypes were multiplied into a class and inevitably more features of the French locomotive were used in later designs. However, the subsequent Bo-Bo and B-B developments used the Swiss traction motors. No doubt the Swiss experience with ac motors, requiring a more robust machine than the dc equivalent, led their engineers to produce a more reliable motor.

ECHO FROM THE PAST

Grünenwald: 1961. An HGe2/2 No.5 [built 1913 by SLM/BBC] of the Stans Engelbergbahn passes the Bascule bridge. *Photo: [LSE] Hardy-Randall collection*

Swiss Transport News

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