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WHAT SYSTEM FOR THE SIMPLON?

PART ONE

Tony Rowbotham

The south portal of the Simplon Tunnel from the loco cab. PHOTO: Robin Oxborough

Last year was the centenary of the 1906 opening of the first bore of the Simplon Tunnel between Switzerland and Italy. The Gotthard Tunnel had been opened twenty four years earlier in 1882, but it was realised during the construction of this first bore that there would be problems not met with the previous tunnel. Firstly, the gradients were more severe, and secondly, whilst the Gotthard was a double track tunnel, the Simplon was a more restrictive single bore, although there were regular through passages to a small service tunnel (which would in time be enlarged to form the second bore). Knowing these facts it was realised that, from what nowadays would be called a Health and Safety problem, steam engines would be impractical, and the line would have to be electrified.

In these early days of development there were three electrification systems to choose from - a direct current (d.c.) system or one of two alternating current (a.c.) systems. The d.c. system was fine for short lines such as tramways, where the length was limited by losses in the conductors (proportional to the current flowing and the lengths involved). The single-phase a.c. system requires two conductors as is found in domestic house wiring. The 3-phase requires three conductors. This is the system used for the National Grid for transmission of power around the country, and explains why the pylons carry either one set or two sets of three conductors. With a.c systems transformers may be used to change the voltage, so very high voltages are used on the Grid. This keeps currents, and so losses, low. As far as their use for traction purposes are concerned, both single- and 3-phase systems have advantages and disadvantages.

The single phase system needs a single overhead wire to supply power to the locomotive, the rails forming the second conductor. However, the 3-phase system needs two overhead wires, again with the rails forming the remaining third conductor. This double wire system results in problems at junctions where the two wires have to cross each other. This can be dealt with by an insulated dead section in the area where they cross, but there is a danger that a locomotive might become stranded at this dead section. Locomotives for 3-phase systems therefore have to have two pick-ups, usually of the bow type in the early days, as wide apart as possible to span the cross over sections.

However, when the motors are considered, the 3-phase motor is of very simple metal construction. The single-phase motor is more like a d.c. motor, and requires power to be passed into the rotating part. This caused a number of problems if a.c. at the national frequency (nowadays 50 cycles per second, or as it has to be known, 50 Hertz) was used. However it was found that if the frequency was much lower, the motors were more practical, but it meant that the power had to be generated by railway owned power stations designed to work at this lower frequency.

In Switzerland at this time it was admitted that perhaps other countries were a little more advanced in traction developments. By the late 1930s though both the BLS and the SBB were considered to be leaders in traction development. The two principal manufacturers took opposite sides in the single- or 3-phase arguments. In 1899 the Brown Boveri Company had opened an experimental 3-phase system on the line between Burgdorf and Thun. The other Company, Maschinenfabrik Oerlikon were investigating the single phase system, incorporating their specially designed low frequency motors. To trial the system, the line between Zurich Seebach and Wettingen was electrified at their expense, and was put into use in 1904.

To decide on a system for the Simplon tunnel a working party was set up in late 1905 and this became particularly interested in a 3-phase 3000V system that had been introduced in 1902 on the Valtellina line in Italy. This line starts in Lecco, and passes up the east side of Lake Como to Chiavenna, with a branch (only electrified as far as Sondrio) to Tirano, which of course is the southern terminus of the RhB Bernina line. This system had been installed by the Ganz Company of Hungary, under their engineer Kálmán Kandó who also had a great input into locomotive and traction design, both in the mechanical and electrical sides. He devised more than one mechanical method of transferring the drive from body-mounted motors to the sprung driving axles. One of these designs, a triangular moulding connecting two motors to one of the driving wheels, he subsequently sold to the Schweizerische Locomotive und Maschinenfabrik Company (SLM) and it was subsequently used, for example, on the Ae3/6II class. Later in the 1920s he started developing a.c. single phase locomotives to work at the national frequency eliminating the need for railway-owned power stations. Not much came of his ideas at the time, but after the war the French took up his ideas and developed the 25 kV 50 Hz system which is now almost a world standard.

In the end the working party decided the Valtellina system would be ideal for the tunnel, and Brown Boveri were instructed to start work on the electrification in the middle of December, only five months before the tunnel was actually opened. The fact that Kálmán Kandó himself was actually on the working party is presumably not relevant?

Editor's note: Tony's interesting article will continue in the September magazine, complete with some wonderful historic photographs.