New Zealand

Arthur's Pass

Train coming out of the 5 Mile Otira Tunnel

The English Electric Company Limited


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NEW ZEALAND RAILWAYS
ARTHUR'S PASS SECTION
(A Comprehensive Contract).

THE history of the South Island of New Zealand furnishes a marked example of the fact that a district particularly favourable to certain industries may remain undeveloped, or have its development retarded, if it lacks convenient access to suitable markets for its products.

The Island is traversed from north to south by an almost impassable range of snow-capped mountains known as the Southern Alps, branching out fan-wise at each end of the coast, and thus isolating from each other the two important provinces of Canterbury and Westland. In many respects these provinces are complementary, each producing or possessing to a remarkable degree what the other lacks; but until the new railway was opened, any interchange of commodities involved a sea journey of some 400 miles, the only direct inland route being the coach road over Arthur's Pass, 3,000 ft. above sea level.

Therefore, it was of vital importance that a direct means of communication should be established. A variety of proposals had been put forward from time to time, but financial and engineering difficulties prevented the fruition of a practicable scheme until in 1900 the New Zealand Railway Department decided that the only sound solution was a summit tunnel under Arthur's Pass; it was not until 1907 that a contract was placed, and work was eventually commenced in 1908 at the Otira end and in 1909 at the Arthur's Pass end.

The tunnel, which is the longest railway tunnel in the British Empire, is 5½ miles long, with a grade of 1 in 33, and is entirely in solid rock except for a few hundred feet at the portals; it is lined throughout.

The large illustration on the cover shows the view from above the Otira end of the tunnel with the Rolleston River Bridge in the foreground; the smaller view is of an electric train emerging from the tunnel at that end.
In view of the severe gradient and the long tunnel, no other system than electric haulage was seriously considered, and in due course a comprehensive offer by the English Electric Company was accepted for the electrification of the line on the 1500-volt direct-current system with overhead current collection. The contract included the equipment of a steam power station at Otira, the construction of the overhead contact line and of the feeder and tunnel lighting system, and the supply of 5 locomotives for freight and passenger service and a battery locomotive for maintenance and inspection purposes.

The traffic conditions specified were 20,698 ton-miles for freight and 2,050 ton-miles for passenger trains per day; these figures, which include locomotives, make a total of 23,648 ton-miles per day, or 27,195 ton-miles after allowing 15% for shunting operations.

The generating station at Otira contains two 1200-kW., 1650-volt, geared D.C. turbo-generator sets with surface condensers and auxiliaries, two 125-kVA. engine-driven 3-phase alternators for supplying current for lighting the tunnel, stations, power house, sidings, etc., negative and battery booster sets, transformers and main and auxiliary switchgear. Fig. 2 is a general view of the Power Station and Fig. 4 shows one of the 1650-volt, 1200 kW. turbo-generator sets.

The overhead line in the open is of the double catenary type. In the Otira Station area the catenary wires are of 7/12 S.W.G. galvanised steel, stranded, but
Fig. 3. Freight Train on Embankment. The double catenary suspension is carried by wood poles with side bracket arms.

Fig. 4. One of the 1,200 kW., 1,650-Volt, Direct-current Steam Turbo-Generator Sets.
on the main line they are of copper, each 37/13 S.W.G. stranded, .25 sq. in. section. The contact wire is 6/0 S.W.G. grooved and suspended every 15 feet to the catenary by copper wire droppers. Every 300 feet the catenary wires are bonded to the contact wire by a 37/15 S.W.G. copper bond. In the tunnel a single catenary of .5 sq. in. (61/104 in.) stranded copper is used with supports every 90 feet; the arrangement of this and of the cabling can be seen in Fig. 7. In the open the overhead work is carried on wood poles of Australian iron bark, 50 yards apart on straight runs. The insulators are supported on simple angle-iron side brackets above runs of single track. In stations a more complicated lattice bracket is used, and on sidings, where a number of tracks are embraced, a girder of the trussed beam type supported by a wooden pole at each end, the insulators being carried on the top member. Examples of most of these forms of construction are shown in Figs. 3, 5, and 6.

A positive feeder of .5 sq. in. stranded copper is used, bonded every 300 feet to the catenary in the open and every half mile in the tunnel. This feeder is bare in the open and lead-covered in the tunnel. The negative feeder connected to the negative booster is 1 sq. in. in section, consisting, outside the tunnel, of two bare cables, .5 sq. in. each, and of one lead-covered cable in the tunnel. This feeder ends 5.2 miles from the power station where it is bonded to the rails. The bare portions of both positive and negative feeders are carried on steel cross arms fitted with insulators and attached to the poles carrying the overhead contact line. A pilot wire of 7/18 S.W.G. is carried from the power station to Arthur’s Pass Station for the purpose of measuring the rail drop. Two stranded copper bonds 4/0 B. & S. are used at each rail joint and cross bonds between adjacent tracks at every structure. These are connected to the bracket arms of poles or to the cross girders for earthing.

Fig. 5. Train entering Arthur’s Pass Station. This illustration shows the side bracket arm construction used over double tracks.
purposes. All metal work of insulator pins, etc., is earthed to the rail both inside and outside the tunnel.

The 5 locomotives are of the box cab design for the N.Z.R. standard gauge of 3' 6"; they have a driving position at each end, and a 0-4-4-0 wheel arrangement.

They are of the articulated type with the draught and buffing gear attached to the bogies; this arrangement avoids subjecting the cab or underframe to any of the driving stresses. The total weight of each unit is 50 tons. The main motors are of the totally-enclosed forced-ventilated type, and develop 179 h.p. at the tread of the wheel at the one-hour rating. The corresponding speed at 1,500 volts is 18 m.p.h. They are wound for 750 volts and connected in pairs in permanent series. The tractive effort of the locomotive is 14,200 lb. at the one-hour rating.

The control equipment is of the “English Electric” camshaft all-electric type arranged for either single or multiple-unit operation with a single locomotive crew.

The control for one unit consists of an isolating switch, main fuse, overload relay, two magnetically-operated line switches, the camshaft controller and the magnetically-operated reverser. The operating current for the control is obtained either from a rotary transformer or from an emergency storage battery with which each locomotive is equipped, the voltage being 120.

As the whole line is on a gradient of 1 in 33, it is imperative that the brake gear shall be absolutely reliable. The locomotives are fitted with four brakes, viz., rheostatic brake, Westinghouse automatic air brake, Westinghouse straight air brake and hand brake. The rheostatic brake was adopted in preference to the regenerative brake, because the power house supplies the railway load only, and there would, therefore, be occasions when no load would exist to absorb the regenerated energy. The rheostatic brake

Fig. 6. Track and Overhead Work showing two methods of Catenary Suspension.
also renders the locomotive independent of the trolley voltage. Large resistances are provided to dissipate the energy returned from the motors, and a solenoid-operated change-over switch arranges the motor connections for "power" or "brake" as required. The change-over switch is controlled by the reversing barrel which has additional brake positions for forward and reverse operation. The amount of brake resistance in circuit is adjusted by solenoid-operated contactors fitted with metallic-shield blow-outs. These contactors are controlled by the controller handle on the series notches. The resistances are designed to limit the speed on the gradient to 26 miles an hour when two locomotives are holding a passenger train of 200 tons.

Fig. 7. Interior of Tunnel showing Overhead Line and method of supporting cables.

The equipment of the battery locomotive consisted of a 50 BHP. (one-hour rating) 440 volt motor on each of the four driving axles, the latter being driven through single-reduction gearing having a ratio of 15/83.

Reports received after the first six years of working paid tribute to the satisfactory operation of the whole of the generating and traction equipment. The locomotives, which were designed to handle 1,000 tons a day, were dealing with 3,000 tons and had completed an average of over 83,000 miles per unit. The 1650-volt direct-current generators had given an excellent performance, and at that date their commutators had not been touched for over two years.

Following the successful running of the Arthur’s Pass line, the New Zealand Railways decided to adopt electric working for another tunnel section of their lines, that from Christchurch to Lyttelton, the chief port of the province of Canterbury. The comprehensive contract for this, the first electrified suburban line in the Dominion, was also awarded to the English Electric Company, and the line was opened for service in February, 1929. A description of this conversion is contained in a separate publication No. M.38.
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