driving of a 170-foot tunnel, this one on a tangent, before connecting with the old line near Field.

With the gradients improved to this extent, two engines of the same class as the four previously used can haul 980 tons of freight up the valley.

The spiral tunnels were driven through crystallized limestone of a widely distorted nature. In places, the stratification would vary from nearly horizontal to almost vertical, and in others from normal to almost parallel with the direction of the centre line. The hardness and brittleness of the rock varied every few feet, rendering drilling operations difficult. Water seepage through the rock crevices hampered progress on the down-grade ends of each tunnel, while the high altitude (about 5,000 feet) and severe winter weather added to the adverse conditions under which the task was so successfully accomplished.

Roger's Pass Tunnel in the Selkirks.

About 85 miles west of Field, there is at present under construction a double-track tunnel through the Selkirk Range of mountains in British Columbia. The driving of this tunnel is making itself a prominent place in the annals of notable engineering achievements. From portal to portal its centre line will measure 26,400 feet, thereby exceeding by three-fourths of a mile the longest existing tunnel in America. The method by which it is being driven involves the tunnelling of a "pioneer bore" paralleling the centre line of the main tunnel. This feature is new and the interest of tunnel engineers has naturally been aroused the world over. Its adoption arose from the keen desire of the C.P.R. to have the undertaking finished before the close of 1916. There is now no doubt that this aim will be achieved. The world's tunnelling records have been repeatedly broken, and the progress made has certainly vindicated the adoption of the pioneer heading method.

The estimated $12,000,000 expenditure connected with this undertaking is another indication of the efforts that are being made by the Canadian Pacific Railway to eliminate grades and snow troubles that have for years gone hand in hand with Western railway operation. The Selkirk tunnel may be considered an adequate winding-up of vast expenditures and enormous engineering undertakings which the C.P.R. has carried out with a view to perfecting the grade and alignment of its road both east and west of the great wheat fields of the Dominion. The tunnel will bring down the summit elevation of the Selkirk portion of the line from 4,330 feet to 3,791 feet. It will reduce the length of maximum grade from 22.15 miles as at present to 6.61 miles, the maximum grade, 2.2 per cent., remaining the same. It will dispense with about four miles of snow sheds in a length of thirteen miles of main line. It will incidentally reduce the length of the line by about four and a half miles. The total curvature will be considerably reduced and several loops eliminated. Thus, while the maximum train load will remain the same, the operating conditions will be much more favorable in consequence of the lower elevation, the shortening of the grades, and the reduction of expense and delay in the season of snow. In short, one of the most costly sections, from an operating point of view, of the whole system will be entirely eliminated. The large force of pusher engines, snow ploughs and equipment shops, that have necessarily carried on a busy existence at Roger's Pass, in service on both sides of the Selkirk Range, will shortly have to seek ranges anew.

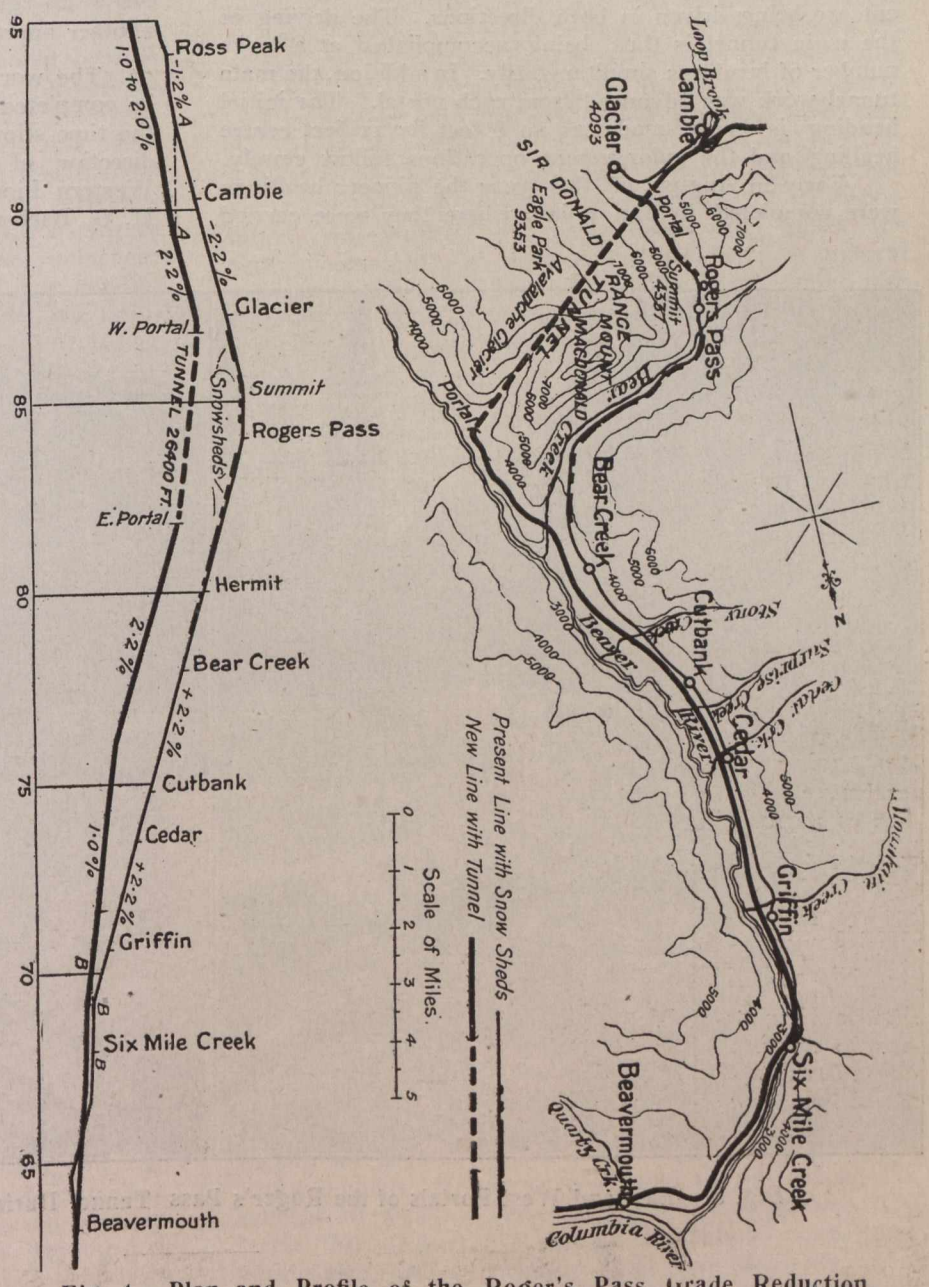

Fig. 4.—Plan and Profile of the Roger's Pass Grade Reduction.

The tunnel, with a bearing under Mount Macdonald of S. 38° 11′ W., is being constructed on a tangent throughout its entire length of five miles. The maximum depth of rock above it is 5,690 feet. For about 1,100 feet at each end the material encountered is clay and boulders, the balance being solid rock, mica, schist and quartzite. Throughout the softer materials the tunnel is being lined with concrete. The finished section will be 24 feet high by 29 feet in width.