

almost impracticable for the pioneer is comparatively easy and smooth for his successor. In the instance of the Canadian Pacific Railway, and especially with Messrs. Langdon and Shepard's division of it, the case was complicated by the immense distance that intervened between the base of their operations or even the end of the track and the points where the earthwork and the bridging was being carried on, as well as by the long length of line over which these operations were being simultaneously executed. The removal of 10 million cubic yards of earth, as for instance in the Suez or Panama Canals is a heavy undertaking, but spread that same amount over 700 miles of country, and every element of cost and difficulty is wonderfully enhanced. An immense quantity of materials has in all these cases to be accumulated an army of men has to be fed and provided for, large quantities of plant and tools and appliances have to be procured, and kept in efficient repair and a vast machinery has to be maintained if the work has to be properly and systematically executed, but in this instance all this had to be done from one end of a thin line of communication and over the extended chain of its own daily increasing length. It was only by the most accurate knowledge, months in advance of every detail that was required, the most careful estimate of when and where and how each party was to be provided for and the most energetic maintenance of the long line of communication that the desired result could be hoped for. It speaks volumes for the executive ability, indomitable energy and business management of the firm that the whole was worked out with no serious hitch, that no important delays occurred and that everything progressed in the same methodical orderly manner that was observable in all their operations.

The work of grading was sub-let in small sections of a mile or more in length to almost sixty different sub-contractors according to the ability or means of each man to execute the length that he undertook, great care being exercised that these sub-contracts should be well within the limit of each man's power to complete them within the time specified and so well was this managed that only in one or two instances out of 300 separate contracts was any delay occasioned by these parties not completing their work. As soon as a gang had finished in one place they were removed forward to their next length perhaps 100 or 150 miles ahead and here again in another month or six weeks they were almost certain to be within sound of the track-laying locomotives before their work was entirely finished, nearly all the earthwork was what is usually known as side cuttings, the line being almost exclusively on an embankment the material for which is derived from two parallel ditches on either side of the line, and purposely raised at such an elevation above the prairie as to bring the rails where possible above the average level of the winter's snow. This class of work was done in three different ways; the first by digging out the ditches and casting the material taken out of the trench on the embankment. This work was generally let to three or four men by the "station" or 100 feet length, and it suited the Swedes, Norwegians and Italians who made this class of work their specialty and who often removed on an average 25 cubic yards a day for every man employed in their gangs. There is little plant or capital required for this work, and one man on the bank will level off and

dress up the labor of a score of casters employed on the ditches. The second mode, and most popular with the American workmen for removing the earth was by scraping. In this case the ditches are plowed for a length of 150 or 200 yards and the loosened material is then hauled in a rounded iron box on to the bank by a pair of horses, the scrapers removing at each haul about one-fifth of a cubic yard of material. Where the bank is alone seven or eight feet and the haul unusually long, larger scrapers or boxes are used and they are mounted upon wheels carrying as much as half a yard at each charge. This is undoubtedly the most economical way of removing earth or sand from a side ditch on to an embankment. Two horses, one man driving and one man attending to the scraper will handle easily from 60 to 100 cubic yards per day in ordinary material with the small scrapers where the haul is not long, or double this quantity with the wheel scrapers where the material is sandy, and the circumstances all favorable. There is besides, this advantage with the scrapers, that the banks became thoroughly consolidated with the constant passage of the horses and their load over them, and that when once dressed off they are less liable to subsidence and getting out of shape. The third system adopted was by grading-machines, a rather cumbersome and clumsy-looking affair and requiring from 8 to 12 horses to draw it but doing its work pretty well upon the whole and although somewhat complicated in its machinery giving less trouble than might be expected, from break-downs or the necessity of repairing the working parts. It consists of a plough mounted upon wheels and so arranged that it can be raised or lowered at pleasure by the ploughman who rides upon the framework immediately above the plough and can watch exactly the depth necessary to cut to keep it properly working. The portion cut out by the plough is turned over onto a shell table slightly inclined and from which it is pushed on to an endless band one end of which is as close to the ground as it can be arranged and the other passes over a movable pulley that can be raised or lowered and which delivers the earth at an elevation of from 4 to 8 feet above the point from which it was excavated on to the railway embankment. These machines would average from 800 to 1,000 c. y. per day but the amount of subsidence in the embankment which was generally under 10% in scraper work raised from 15 to 18% in the banks made by the graders.

Following the grading parties and just in advance of the tracklayers were two bridge gangs, working one night and the other day, and as every stick of timber had to be brought by the completed road itself, mostly from Rat Portage, 140 miles east of Winnipeg, and generally 500 or 600 miles from the place where it was required, and as it was important to reduce the freighting from the end of the track to as short a distance as possible, the bridge timber was generally brought up at night, so as to interfere as little as possible with the tracklaying. From this point it had to be hauled along the prairie eight or ten miles to the place where the bridge was to be built. Openings for water courses and the ordinary drainage of the country consisted generally of four bends of piles, four in a row, and for these structures two pile drivers were brought forward, and as soon as the piles were driven the framers were set to work cutting them off to the proper length and put-