

plank in 6 feet lengths, and wedges bearing upon these planks were driven until the post took a full bearing against the wall-plate above. The posts were spaced by 2"x12" plank at foot and head. The lagging and packing were carried up simultaneously from the floor level, but it was not considered necessary to keep this work right up as in the case of the arch lagging, and it often fell considerably behind, the shale on such occasions proving itself amply strong to stand without support during the short period of exposure, the rate of disintegration being very slow in the unchanging atmosphere of the tunnel. No provision was made in this system for side long pressure, and no need of such provision was developed.

DIFFICULTIES AND ALTERATIONS OF TIMBERING.

The details of the system were varied to suit circumstances. The heaviest pressure (immediate and future) was anticipated at the portal, and the end wall-plates were accordingly carried well out, and all the ragged voids between the lagging and the portal slope filled with timber blocks; and for the first 45 ft. at the entrance 4" lagging was used over the arch, and 3" behind the plumb posts, these being reduced to 3" and 2" respectively for the remainder of the tunnel. The arch and plumb post spacing was 3 ft. centre to centre: a proposition to maintain the thickness of the lagging at the end of the first 45 ft. and to increase the bib spacing being considered and rejected.

As described hereafter, the wall-plates were set narrow, high and oanted slightly inwards, the effect being to leave the segment joints open at the back and tight on the front, so that the joints would take a full bearing when the pressure came on and the edges yielded under it. Near the centre of the tunnel it was noticed that the joints of the arches on three wall-plates had opened at their lower edges indicating heavy downward pressure. The wall-plates were immediately dapped to receive extra arches; these were similar to the existing arches in every respect, except that one of the end segments was cut off short and wedges were placed between it and the wall-plate, by driving which the arch was forced to a full bearing against the lagging. For two wall-plates after this occurrence, seven arches were placed on a wall-plate instead of five; but as the indications of pressure then ceased, the five were again adopted.

GRADE AND ALIGNMENT.

By reason of the general plan of construction necessarily adopted, the company had to excavate a large and expensive section; but this section was reduced wherever practicable, and thus the clearance between the systems of lining was reduced to a minimum, necessitating very careful placing of the timbering. The wall-plates were the determining members of the timber system, and they were, therefore, placed by the engineering staff. The plan of operations was as follows:

Taking advantage of the fact that the main tangent in the tunnel passed out of the portal at the curved end well within the section, this line was established by five hubs, one over each portal, to serve as back-sights, one on the summit and one well away from each portal, in such position as to command a full view of it. These latter served as instrument stations, and from them the line could be run right into the heading when necessary. No permanent points were established in the tunnel, the line being always brought up from the outside points when required; the P.T. was established temporarily and the curve run in from the tunnel tangent. The signal used in the tunnel was a small miner's lamp with a plumb bob hung below the centre of the flame. When the tunnel was smoky, recourse was had to the gasoline lamps used to light the tunnel. These were known as "electric torches," and had a long pendant arm of gas pipe terminating in a bend and a small circular nest of burners, the plumb bob being attached to the centre of this nest. On very bad days for seeing, the speediest method was to establish points on the tangents as far as could be readily seen, and then to move the instrument up into the heading and get it into range