

sticks of dynamite to an outside hole and 15 to a centre one. The drilling and blasting of the bench though simple required skillful management, the points to be guarded against being: damage to plumb posts and arch timbers, danger of uncovering too great a length of the wall-plate at a single shot, and complete avoidance of any interference with the progress of the heading.

The muck was taken out to the dump in side-dumpers of about one yd. practical capacity run in trains of two, the heading muckers loading one through the scaffold car shoots, while the bench men loaded the other, the bench men having to clean up to the face of the bench before the next blast was ready. Where the rock shot down in large masses, progress was much aided by the use of stone flats mounted, so that the platforms were flush with the tops of their wheels, on to which heavy rock could be barred without blockholing or extra handling. The bench was kept about two wall-plate lengths behind the heading, and made the same average progress. This progress was about $2\frac{1}{2}$ ft. per shift; the actual excavation was made at a rate of 5 ft. per shift, but the time consumed in pointing down odd projections, timbering, lagging and packing being equal to that spent on rough excavation, the progress rate was only $2\frac{1}{2}$ ft. per shift.

PROGRESS OF EXCAVATION.

The north heading started under on April 17th, the south heading being delayed by a heavy approach cut until June 3rd. No record was kept of the monthly progress, the irregularities of the forces and delays occasioned by lack of timber rendered all such records valueless. The headings were holed on Sept. 17th, and the bench was finished by Oct. 15th, the work having been in progress for just six months. The heading was driven with great care, and no exceptional record was made until the night before the holing, when two gangs drove 20 ft. of heading of rapidly diminishing cross-section in a desperate effort to pierce the 24 feet remaining in the tunnel. The driving of the bench was of course limited by the heading, but after its completion the pick of the forces were placed on the bench, and with gangs increased to one foreman, 3 drillers, 12 muckers and nipper, the rate of progress rose to $3\frac{1}{2}$ feet per shift, the bench being blown in 6 ft. holds.

DIFFICULTIES IN EXCAVATION.

No trouble was experienced with the bench anywhere, but the heading was frequently in bad ground. At the north portal the top of the heading passed into a shattered bed of sandstone rock, which could not be shot down without disturbing a considerable amount of material on the portal slope. Here a 6' x 8' drift was made under the sandstone, and the heading expanded to its full section and timbered at the second wall-plate, and the first wall-plate length was driven outwards, the shattered rock being caught up by timbers as quickly as the excavation was completed.

As the tunnel grade fell and the sandstone rose to the southward, the heading was soon clear of the sandstone, which made an admirable roof for a season. The shale had very little adhesion to the sandstone, and when the sandstone bed and the tunnel section separated, it soon proved itself not sufficiently strong to hold up across the span by coming down in heavy falls, which left the bottom of the sandstone exposed. The material between the bottom of the sandstone and the top of the section was accordingly excavated, until its thickness grew such that the cost of its removal became an item of considerable expense when it was determined to hold it in place. This material where removed was classified as "fallen material."

Up to this point the system had been to drive a full heading for a wall-plate length, and then timber it up. This was now changed, and the heading was driven with an arched longitudinal section having full height at the end of the preceding wall-plate, and being barely high enough at the end of the new wall-plate to admit of its being easily