maining firm for a short time after being opened up, was encouraging. As it turned out, the fear of loosening part of the tunnel by the side sliding in, while the wall-plate was carried on batter posts, was groundless. There was no settlement of the wall-plate of more than 1 in., and the work was hastened and cheapened by this method much more than by driving drifts to place posts before excavating the core of the tunnel. The excavation of this earth section was finished in December, 1914.

Pioneer Headings in General.—The pioneer tunnel, in rock, was 7 ft. high and 8 ft. wide. It was driven with light hammer drills, using hollow steel, with water attachments. Three drills, in general, but four in the

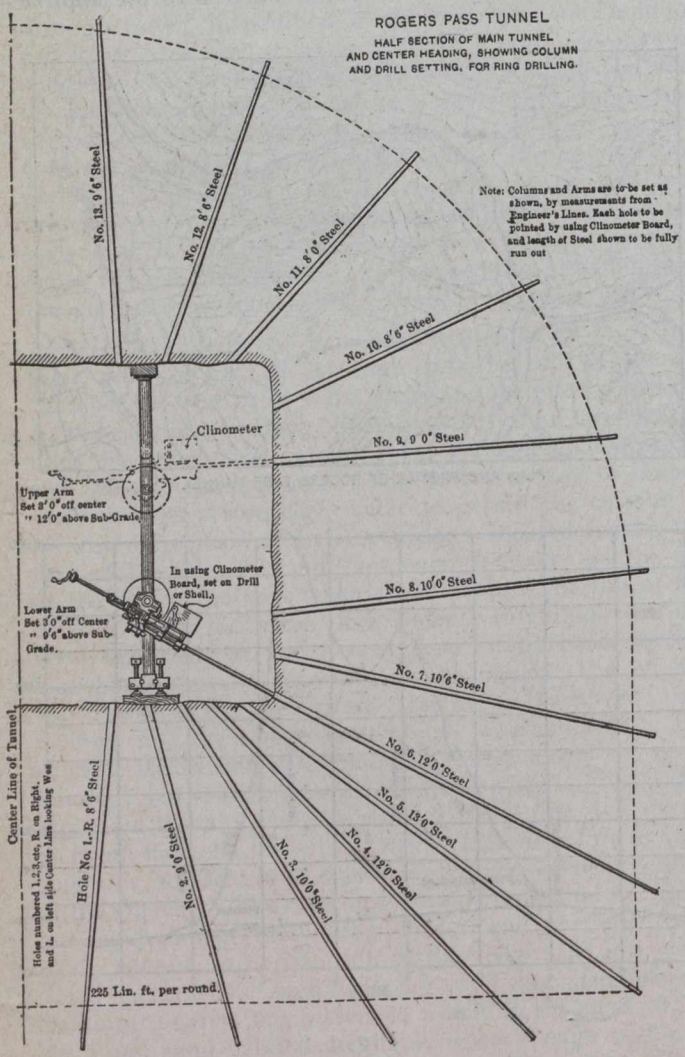

Fig. 2.

hardest rock, were used in a heading. Spare drill machines, for the replacement of drills out of order, were kept conveniently at hand in the heading. No repairs were made underground. The hammer drills are convenient and rapid, the delay and expense of their constant breakage perhaps balancing the advantage of speed under ordinary conditions. The drills are mounted on a light horizontal bar, about 18 ins. below the roof line. Air and water are taken over the muck pile, or on hooks in the side, by a single hose line for each, to a manifold from which short individual hose lines supply the drills.

Light cars (½ cu. yd.) were used for muck, and the latter was taken off the track, instead of building sidings for this purpose. Shovelling plates were used at the face and on the side away from the track for some distance back of the face, in order to facilitate the handling of empty muck cars. The ventilating pipe was a 12-in. wooden water pipe connected to the Connersville blowers used for the exhaust. This pipe was hung on the side away from the track, close up to the roof and was carried to within 20 ft. of the face. Little damage was done to this pipe by blasting. The blowers were started exhausting when the first shot was fired, or a little before, and were run for 20 minutes. The men got back to work in from 5 to 10 minutes. No compressed air was allowed to be blown out for ventilating purposes. After a round was shot, the drillers followed the smoke back, barring down the roof, bringing explosives to re-shoot, and wetting down the muck pile, sides, roof, and face with water hose. The muckers cleared the track and began loading the muck which was scattered back.

When no further blasting was required, the lights were hung, the foreman sighted the line and grade point in the face, and the drilling gang set up the horizontal bar, placed their drills and proceeded. There was rarely any muck to be handled before the drilling could be started, as it was thrown back from the face by the heavy loading in the bottom holes and the fact that they were shot last, for this purpose. There were two helpers to three drills, and they brought up and changed the steel and adjusted the drill machines. When the drilling from the upper set-up was completed, the drillers took down the machines and carried them back, with the hose connections still attached, and oiled them up. After the mucking was done, the bar was dropped to the lower set-up, near the floor, and the drills were set to drill the bottom holes or lifters. The drills were carried forward, put on the bar, and were drilling sometimes in less than 2 minutes after the bar was dropped. While the bottom holes were being drilled, the muckers laid the track, adjusted and covered the mucking sheets with muck, and brought up the explosives. The holes were loaded by the machine men, helpers, and foremen.

For the small part of the tunnel where re-shooting was not necessary, an 8-hour shift could do two rounds per shift, or a little better. Two men pick down the muck, and three men load the car and push it out, while three others stand by with an empty car, ready to put it on the track and load it. The three men taking out the loaded car return near the face with an empty car, take it off the track, and rest until the load comes out. The men get a rest from the monotony of steady continuous shovelling, and the empty car is available at once after the load goes back. The pipes for ventilating, and for air and water were laid by a pipe man and helper, who looked after several headings.

Doing this work with muckers was unsatisfactory. Muck cars were taken from the heading back to a siding by a single mule, and from there to the dump by a two or three-mule team driven tandem, until this method became inadequate, and then compressed-air locomotive haulage was substituted for the long haul. The heading muck cars, after the shovel and switching track had cleared a cross-cut, were taken to the cross-cut, pulled up an incline trestle by air hoist and cable, and dumped into standard-gauge cars. The cross-cuts are from 1,500 to 2,000 ft. apart. Air pressure was maintained at about 90 lbs. at the drills, which required 125 lbs. at the compressors toward the end of the work.

Main Heading.—The main heading, generally known on the work as the "Centre Heading," was entirely through the rock section. It was 11 ft. wide and 9 ft. high, the centre line being the same as that of the completed tunnel and the bottom being 6 ft. above the sub-