the tracks of the Chicago Junction, a short terminal and switching road, and the provision of goggles by the New York Central for men engaged in chipping rails or other work endangering their eyes.

RESULTS

The results of the safety campaign already undertaken in the maintenance department are certain but difficult to measure accurately. The accident statistics of the Interstate Commerce Commission do not indicate any marked decrease in the number of accidents to maintenance employees, but as stated above, these figures are subject to question and the best indication of work so far done and the possibilities of future work along this line is furnished by the reports of individual roads that have carefully studied this subject. The following typical examples are not necessarily the record performances, even on the roads quoted, but indicate in a general way what results are being secured. On the Baltimore & Ohio the number of injuries to maintenance men reported to the Interstate Commerce Commission during the first half of 1914 was reduced 66 per cent as compared with the same period in 1913. On the Chicago & North Western the reduction in accidents during the fiscal year 1914 as compared with the fiscal year 1910, when the safety work was started, amounted to 39.3 per cent in deaths to track men, 27.7 per cent in injuries to track men, 33.3 per cent in deaths to bridge men and 38.8 per cent in injuries to bridge men. The average decrease in accidents to all employees was 41.1 per cent, showing that the effectiveness of the movement in the maintenance department has been very nearly up to the average. On the Chicago Great Western the safety work in the maintenance department has decreased accidents until the maintenance men sustain only 29 per cent of the accidents, although they form 43 per cent of the total number of employees. The El Paso & Southwestern safety department has succeeded in reducing the number of fatal accidents to track men 37.5 per cent and the injuries 16 per cent during the fiscal year 1914 as compared with the previous year. Similar figures on the Wabash show a decrease of 46 per cent in fatal and 11 per cent in non-fatal injuries.

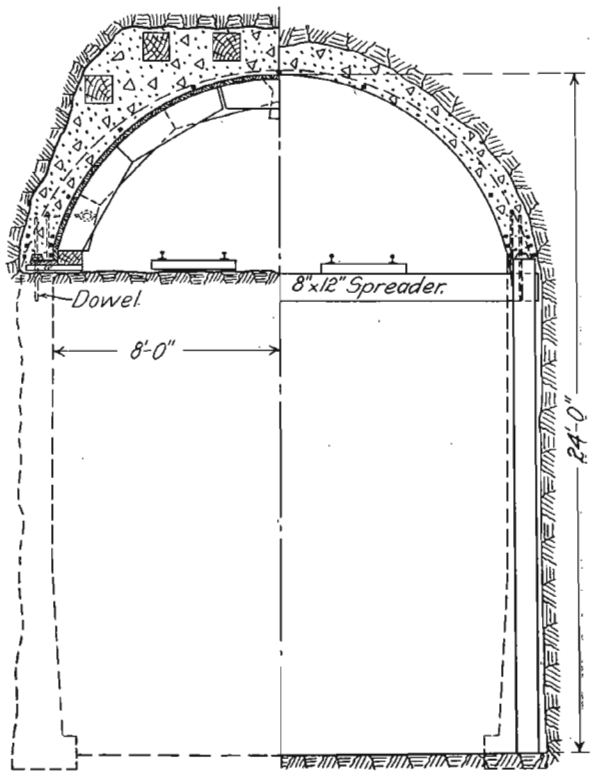
LINING THE SNOQUALMIE TUNNEL

In the construction of the Snoqualmie tunnel through the summit of the Cascade mountains about 60 miles east of Seattle, Wash., the Chicago, Milwaukee & St. Paul is placing the concrete lining for the arch section before excavating the bench material, for a distance of about 3,000 ft. near the east end. The general details of construction of this 2¼-mile tunnel were described in the *Railway Age Gazette* of May 29, 1914. The greater portion of the tunnel was driven from the west portal where the European or bottom-heading method was adopted. At the east end the approach cut was not completed at the time it was desired to start the heading and a top center heading was driven at this end. This heading was then widened out on each side to the full arch section.

The rock at the east end is badly stratified in many places, the seams being filled with talc, and the tunnel bore requiring immediate support. The reason for placing the permanent lining before the removal of the bench was to save the expense of the customary timbering under such conditions and to provide additional safeguards for the men. Sectional forms were built, the concrete was brought in in ½-yd. cars which were dumped into boxes between the tracks, and it was then shoveled into the forms. In some instances the character of the material made it necessary to support the roof temporarily with crown bars which were concreted in place.

After the arch ring was completed, shafts were driven to grade along one side of the tunnel at intervals of 1,000 ft. and connected with a 9 ft. by 8 ft. drift on grade. The drift was then provided with temporary stoping timbers and the remaining bench material was removed by cars, after which the side walls were poured in the usual manner through a chute. The closure between the side walls and the arch was made as far as possible by placing the concrete by hand and before the forms were removed the joint was grouted, the grout gaining entrance to the joint by means of a 2-in. pipe placed in the arch lining. For a part of this work a Ransome grouting machine was used and on the remainder a small gun was employed which was built on the job.

All of this bench has now been removed below this arch without any settlement or indication of cracks and the lining has



Sections Showing Method of Placing Concrete Arch Lining Before Removing Bench Excavation

been completed within the past week. It has, therefore, resulted in a considerable saving in timber and in cost of construction. The tunnel was placed in service for the regular passage of trains on January 15. In common with other details of this project, all of which are being handled by company forces, this method was developed by J. I. Horrocks, engineer and superintendent of construction, under the general supervision of E. O. Reeder, assistant chief engineer, and C. F. Loweth, chief engineer, of the St. Paul.

EARLY CAST IRON.—At a recent monthly meeting of the Ipswich Engineering Society, of England, an interesting lecture was delivered by Robert Buchanan, of Birmingham, on "The Origin and Development of the Foundry Cupola." Mr. Buchanan said that he owned what he believed was the oldest piece of iron in the world, a portion of a gully grate from the floor of some ruins at Ephesus, which still showed the iron crystals. The first record of cast iron being used was in 1543, when in Sussex a man named Hogg made cannon. Personally he believed that the system must have been discovered before, because in 1595 it was stated that cannon of 6,000 lb. weight were made, and he did not think such progress could possibly have been made in 50 years. The first record of a cooking-pot being made of cast iron was 160 years after cannon were first cast, so that it seemed that in those days armaments led the metallurgical world as they did in a great degree at the present day.—*Engineering.*