FITTING-SHOP AT MESSRS. LUKE'S STOVE-MAKING BRANCH.

on the use of copper alone. These boilers are constructed on the horseshoe principle and they are said to heat much more rapidly than those of the old-fashioned shoe type. Another specialty carried out under the same roof as the stove-making business is cast and wrought iron work of every description; thus, the variety of products extends beyond ranges and oven work of all kinds to fences and gates and ornamental iron work generally.

In concluding an interesting visit to Messrs. Luke's stove-making branch the representative of PROGRESS was conducted through the showroom and general offices situated on the Allen-street front. The showroom contains many samples of the products of the works, and the general offices are both roomy and well-lighted, two features conducing to the rapid despatch of the firm's engineering, boiler-making and brass-founding business conducted at the Te Aro Foundry.

The whole of the works, both in connection with the range department in Allen street and the Te Aro Foundry in Victoria street, are under the joint management of Messrs. Chas. M. and J. P. Luke, as managing directors.

THE GALLITZIN TUNNEL.

BY PRESTON CHAMBERS, C.E., AUCKLAND.

By last mail news reached us of the completion of the Gallitzin tunnel on the Pennsylvania Railway, U.S.A. It was designed to relieve the traffic across the Alleghany mountains at an elevation of 3,000 ft. above sea level 11 miles west of Altoona.

Until recently all east-bound traffic passed through the original double-track tunnel known as the old Gortage road, built in 1851–5 and widened for railway use in 1898; and all west-bound traffic took the Alleghany tunnel about 200 yards north of it. This latter tunnel, while unnecessarily wide for a single track, has been found to be rather dangerously narrow for double lines. It has a horseshoe cross-section of 24 ft. wide by 20ft. high, and could not therefore advisedly be simultaneously used for both freight and passenger service. Since the completion of the new tunnel each west-bound track passes through a separate tunnel while both east-bound tracks take the old Gortage road.

The new Gallitzin tunnel is parallel with the Alleghany one, and 80ft. distant from it. It has a down grade west to east of 1 in 100, and is driven chiefly through rock at a depth of about 300 ft. It has a cross-section of 17½ ft. wide by 20 ft. high in the clear above the top of the rail. The side walls are rubble for 9 ft. with a concrete roof arch 22 in. thick, with a springing line 15 ft. above the bottom of the side wall. Safety alcoves are placed 200 ft. apart on alternate sides.

The rock negotiated is of a variable character. At the west end of the tunnel sandstone was encountered; at the east end chiefly shale. Limestone, coal and slate were also in evidence, with a little fire-clay. No trouble was experienced from water, the tunnel being driven from both ends without air shafts. The headings were started 14 ft. wide by 9 ft. high, and enlarged to the full dimensions in advance of the bench work. This was removed in two lifts. The first one was 7 ft. high, and the second 10 ft. The total excavation for the tunnel in progress was 21 cubic yards.

The work in the heading at the west end was easier than that at the east end. Four pneumatic Ingersoll-Sergeant drills operated on two columns, making 16 holes about 10 ft. deep in a full shift of 8 hours. The heading was then enlarged by three holes on each side drilled during the night while the permanent timbers were being set, and the top bench, which was kept about 50 ft. behind, was being perforated with a transverse row of six holes. These were fired at 5 a.m. and all debris removed by 10 a.m. Forcite gelatine was the explosive used throughout the workings. All debris was shifted by Marion "A" steam shovels, with the shortened dipper handles and booms, in conjunction with 3 yd. wooden side-dump cars running on a 3 ft gauge track. At the west end, where the grade rose from the head, the ballast trucks were switched out by a Lambert hauler. At the east end no hoisting was required.

At this end of the tunnel the material in the heading was often so loose that satisfactory blasting was extremely difficult. The charges blew out instead of bringing down the rock, and a large amount of extra timbering had to be resorted to in the way of intermediate verticals and side posts for the support of the arching. Although the bench work was rendered easier the general progress at this end averaged only 80 ft per month as against about 200 ft. per month at the west end where little timbering was found to be necessary.

Air was delivered from a power house at a pressure of 100 lbs. through a 6in. pipe carried between the rails of the track to the old parallel tunnel. At the west-end entrance a 4 in. branch was taken from this pipe and carried to the west heading, being reduced as it advanced to 3 and 2 inches. The main pipe was reduced to 5 in., and carried through the old tunnel to the east end, where it was reduced to 4in. and carried to the new tunnel and returned through it towards the west heading, thus providing an air supply always conveniently accessible throughout its entire length.

The side walls were built by the day shifts. Single lengths of 6 in. cast-iron drain piping were placed at 20 ft. intervals horizontally into the foot of the walls and connected, by reducing elbows, to 4 in. cast-iron piping carried up to the solid masonry, or concrete backing, to the haunches where the open ends of the piping were covered with broken stone to facilitate drainage. The facing of the walls was battered to a line fixed by carefully adjusted wooden turnplates. This system of drainage was found perfectly satisfactory throughout the tunnel, except for a short distance near the western end, where a persistent leakage was rectified by stripping the arch-packing and laying in a waterproofing of tar. The cavity was then carefully repacked with dry rubble around the permanent timbering, and no further trouble was experienced.

After the completion of the tunnel very great inconvenience was occasioned by the smoke and fumes ejected by the passing locomotives. The atmosphere at times became so overcharged with carbonic-acid gas as to be unbearable, and remedial action was absolutely imperative. Relief was effected by the construction of a ventilating apparatus, consisting of a sheet-iron hood about 50 ft. long enclosing a track, and having an inner surface coincident with the soffit of the tunnel arch and walls. The outer surface converged from the outer end of the hood to the entrance of the tunnel so as to give a wedge shaped cross-section. A Sturtevant blower was installed at the extremity of the hood on each side and which delivered air through it to the tunnel entrance, where a narrow opening in the inner face of the hood permitted the blast to be forced into the tunnel parallel with its axis. Trains now pass through the tunnel in one direction only, and as the grade is up from this end they are usually drawn by two locomotives in front and a pusher behind. As soon as the leading locomotive enters the tunnel the fan is started and the large volume of air forced into the space between the train and the tunnel lining drives the smoke in advance of the locomotive, and, there being an abundance of fresh air, the driver can keep the cab windows open. The second locomotive does not work in the tunnel, and the smoke from the pusher never reaches the front of the train.

The total amount of concrete used was 12,000 cubic yards, for which 12,400 bushels of Portland cement were required. On an average 2½ lbs. of explosive were expended per cubic yard. About 2 000,000 ft. of permanent timbering was erected. The tunnel was built in 22 months with a force of 300 men and an outlay of £100,000. It is a very striking example of what can be effected by well-directed energy supplemented by the necessary funds

INTERIOR OF SHOWROOM AT MESSRS. LUKE'S STOVE-MAKING BRANCH