

25 ft. wide, with an overhead gallery of the same width to be used for lighter machinery. In the erecting shop there are three tracks with pits, and two intermediate supply tracks. The locomotives are handled by two 60-ton electric travelling cranes, each having a 10-ton auxiliary hoist. In the boiler shop there is a 20-ton travelling crane on the same runway, and numerous jib cranes. In the machine shop there is one 15-ton crane, and one 10-ton crane, 50 ft. span. All these cranes are driven by continuous current motors, the voltage being 250. Besides this, the boiler shop has an hydraulic crane in the riveting tower to serve the riveter.

In the designing of the buildings, adaptation to their respective uses, and economy in both first cost and maintenance, were the prime considerations. It is hoped, however, that the appearance of the buildings is not objectionable, though perhaps not æsthetically pleasing. Some care was indeed taken to avoid disfiguring construction. Among the principal requirements to be met in the construction may be mentioned the necessity for good lighting in all parts of the buildings and in all weathers. To insure this the brick walls are pierced with as much window surface as appeared safe without endangering their safety. Steel frame construction for the side walls was, however, not used, the walls being self-supported and also carrying the trusses, except in the south wall of the locomotive shop. The windows occupy about 50% of the wall surface. In addition to this, almost all the buildings have skylights. These generally run transversely, extending half the width of the buildings. As there is a skylight in every bay, and its width is half the width of the bay, the skylight area is about 25% of the total roof area. These skylights are of galvanized iron framing, and covered with $\frac{3}{8}$ in. rough-cast glass laid in putty. The panes are two ft. wide and in one piece for each half skylight, avoiding all joints in the glass. A revolving ventilator is generally fitted to each skylight. Another important requirement was the greatest possible safety against destruction by fire, consistent with reasonable economy. The buildings are all of them of a simple, strong construction in conformity with the rules for slow burning mill construction as developed by the Massachusetts Mill Owners' Mutual Insurance Companies. The walls are of hard-burned brick, laid in Portland cement mortar. They are from 12 to 16 ins. thick, with pilasters about 20 ft. apart. In the arrangement of the roof framing and the spacing of the supporting columns, the demand of the operating department with regard to the lay-out of the machinery had to be considered, and the result is in some cases a compromise between its requirements and economy in construction. It is believed, however, that as built, no important requirement in the use of the shops has been sacrificed. The framing of the roofs is of three kinds; 1st, a column and girder construction (usually in timber), as in the truck shop and frog shop, the passenger car shops and the cabinet shop; 2nd, a roof frame consisting of Howe trusses supported on steel columns, as in the freight car shop, planing mill and car machine shop; 3rd, heavy steel columns and trusses are used, as in the locomotive shop, foundries and blacksmith shop. It may be added that the wooden Howe trusses in the car shops were adopted instead of steel trusses mainly to save time. The saving in cost did not exceed 12½%. In the outcome there was probably no saving of time from the use of timber, but on the other hand, no great disadvantage resulted from using this form of construction. The heavy timber girder and post construction, as used in the truck shop, etc., was adopted, as being cheaper and better than truss work, and its use is believed to be fully justified. The principles of mill construction

were fully carried out; the purlines in no case being less than 6x12 ins., and in many buildings 8x16 ins. They are spaced from 8 to 10 ft. apart. The roof boards are 3 ins. thick in all cases. In the locomotive shop they are 11 ins. wide with tongue and groove. In most of the other buildings this roofing was built up of strips of 3x3, laid with broken joints in random lengths, and well nailed horizontally and vertically. These strips were surfaced on three sides, but were not tongued and grooved. On top of the boards a four-ply tar and gravel roofing of standard construction was laid. There is a galvanized iron flashing around the skylights, but there are no gutters or downspouts. The flooring throughout consists of 3 ins. unmatched plank, nailed to cedar sleepers 4 ft. apart and bedded in from 15 to 18 ins. cinders. It may be added that the roof loads were taken at 70 lbs. per sq. ft. (total loading), and the stresses in the timber beams at 1,500 lbs. per sq. in. The structural steel is of simple construction, though every attempt was made to secure rigidity, especially where crane runways had to be supported. Tensile stresses are 15,000 lbs. per sq. in. on the net section, and compressive stresses 12,000 lbs. reduced for length. In the crane runway girders the tensile stresses were reduced to 12,500 lbs. per sq. in.

The heating of the shops was the subject of an extended study, in order to determine the most practicable and feasible system. This question was necessarily taken up in connection with the design of the power plant. The economy of producing power in an independent station is dependent on the utilization of the exhaust steam for heating. As exhaust steam possesses from 85% to 90% of the heat units contained in the steam before it has passed through the engines, it is clear that every consideration of economy will lead to its utilization if possible. Whether any additional boilers will be required over and above those necessary for power will depend, of course, on the amount of power, the size of the shops, and the prevailing temperature. In the Angus shops, about 26,000,000 cubic feet had to be heated in the various shops, while the h.p. installed in the engine room of the power house is nearly 3,000. A somewhat careful calculation, based upon the prevailing practice, and a study of the temperatures in Montreal as recorded by McGill University for many years past, led to the conclusion that about 2,400 boiler h.p. would be required, and that the heating requirements were very nearly the same as the power requirements under average weather conditions. The choice lay between three systems of heating: the hot blast, ordinary direct steam radiation and a hot water system. In the first, exhaust and live steam are taken to one or more points in each building, and used there to heat coils of steam pipe, and also to drive a small engine operating a fan. Air is taken either from outdoors or from the inside of the building, drawn by the fan over the heating coils so as to be warmed to about 130 degrees, and then blown through ducts over or above ground to different parts of the building. This is the system finally adopted for all the buildings, though the hot water system presented some advantages. The requisite radiating surface for heating by hot water, is, however, difficult to obtain, and the cost of the system is considerably greater. In the arrangement of the pipes care was taken to proportion them in such a way as to utilize the exhaust steam as much as possible. In extreme weather certain portions of the buildings will have to be heated by live steam by day as well as by night. A considerable amount of economy was possible in proportioning the pipes to fit the estimated amount of exhaust steam, rather than the total that might possibly be available. The steam pipes are carried from the power house to the several buildings in a tunnel 6 ft. high and

4½ ft. wide, built of brick. A few of the smaller mains are, however, carried under ground in wooden boxes.

All the steam for power, whether for mechanical or lighting purposes, and also for heating, will be generated in the central power plant. The boiler room contains four 415 h.p. Babcock & Wilcox boilers built for 160 lbs. pressure, and also one 320 h.p. high pressure boiler built for 300 lbs. working pressure. The latter will be used for testing the completed locomotive boilers in the boiler shop, the steam being conveyed in a special 4 in. high pressure main. All the boilers are fitted with Babcock & Wilcox patent superheaters, to superheat the steam 150 degrees Fahrenheit. Neemes patent shear cut shaking grates, manufactured by the Babcock & Wilcox Co. are used instead of the ordinary grate bars. There will be installed in connection with the boilers a fuel economiser of 480 pipes for heating the feed water by means of the waste gases from the boilers. There will also be installed a mechanical draft plant, consisting of two 200 inch special steel plate fans, each directly connected to a navy-type, double enclosed, vertical engine 8 by 5½ ins. The outlet from the fans to be connected into a steel plate stack, 8 ft. in diameter. The induced draft plant and stack is carried on steel work above the economiser to minimize floor space. The boilers and superheaters, induced draft plant, feed pumps, and piping in the boiler room are to be installed by Babcock & Wilcox, Ltd.

The engine and generator equipment is as follows: Three 750 h.p. cross compound engines, non-condensing, connected to 500 k.w. alternating current generators. These have a voltage of 600, and a frequency of 7,200 alternations a minute. The speed of the units is 150. An auxiliary unit of half this size with a simple engine is provided. These generators provide all current for lighting as well as for power, excepting that necessary for cranes and a limited number of variable speed tools. For these, two units are provided, each being a 300 h.p. simple engine direct connected to a d.c. generator producing 250 volts. The speed of these engines is 180. The distribution from the power house to the different shops is by bare wire on steel poles. The motor equipment in the different shops is not yet fully worked out. The larger engines will have individual motors, but group driving will be used for smaller tools, the smallest motor being 10 h.p.

The sewerage system is rather extensive but simple in its character. Two main lines of sewers are carried transversely, connecting with the city sewer on Nolan st. They begin with a diameter of 8 in. at the northern part of the grounds, and increase to 3 by 2 ft. They are connected with all lavatories, etc., and also serve to a limited extent for surface drainage.

The city provides two systems of water mains—one for ordinary uses at a pressure of about 35 lbs.; the other for fire purposes only with a pressure of 90 lbs. a square inch. There are two entirely separate systems of mains all over the grounds for these two services. The supply system has a 6 in. main on the midway, with smaller mains diverging to the different buildings. The fire service consists of a 12 in. main on the midway, and 8, 10 and 12 in. mains encircling the various buildings. About 60 three-way hydrants are placed at different points in the grounds, and are about 150 ft. apart. With the fire mains is also connected the sprinkling system. About 13,000 automatic sprinklers are put in all the buildings, their arrangement being strictly in accordance with the specifications of the underwriters. Two 1,500-gallon underwriters' pumps are placed in the power house as auxiliary measures in connection with the fire service. In addition to the city water supply, the shops have their own supply of water,