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 horse-power 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 or Sturtevant system, 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 outdoor 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.

POWER PLANT.

All power, whether for mechanical or lighting purposes, is generated in the central power plant. This contains four 415-h.p. Babcock & Wilcox boilers of 150 lbs.' pressure, 150 degrees superheat and one B. & W. boiler that can be raised to a pressure of 300 lbs. for test in the completed locomotive boilers in the boiler shop, a special 4-in. main being led to that point. A "Green" economizer is used and a Sturtevant induced draft fan and stack. 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 per 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 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 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 ft. by 2 ft. They are connected with all lavatories, etc., and also serve to a limited extent for surface drainage.

For water supply and fire protection the city provides two systems of water mains—one for ordinary use at a pressure of about 35 lbs., the other for fire purposes only with a pressure of 90 lbs. per sq. in. There are two separate systems of mains all over the grounds for these 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 feet apart. With the fire mains is also connected the sprinkler system. About 13,000 automatic sprinklers are put in all the buildings, and two 1,500 gallon underwriters' pumps are placed in the power-house as auxiliary measures. In addition to the city water supply, the shops have their own supply of water which consists of two artesian wells 6-in. in diameter and 550 feet deep, sunk through the limestone rock close to the power-house. It is believed that these will furnish nearly 20,000 gallons per hour of very pure water.

As a further safeguard against fire, an open reservoir 66-ft. in diameter with a capacity of 500,000 United States gallons, has been provided. A 75,000-gallon steel tank, 50-ft. in height serves to maintain a uniform head on the supply pipes and gives additional storage.

The general welfare of the employees has been looked after to an unusual degree. A very complete system of lavatories is provided; the latest sanitary plumbing will be installed, and the lavatories are in every case under the same roof as the main building, thus obviating the necessity for the men to go out of doors, which in this climate is very objectionable in winter.

The system of heating also provides most excellent ventilation. Individual clothes lockers made of open iron work will be provided to hold the men's outer clothing while they are at work; while the drinking water taken from the artesian wells will be purer than that obtainable anywhere else in the city.

It is impossible in this brief paper to refer to the machinery to be installed in the different buildings. In passing mention may be made of the wheel foundry equipment. This is the well-known Whiting rectangular system, which has been worked out with great care by the Whiting Foundry Equipment Company, and it is hoped will produce car wheels very economically and of high grade. The Grey Iron Foundry, in like manner, is to be equipped according to the latest and best practice.

The largest locomotive shop is to be fitted with latest machinery working high grade steels of the highest speeds called for by proper economy.

The boiler shop at the west end of the locomotive shop will have a 17-ft. gap hydraulic elevator with a 65-ft. rivetting tower for holding the 25-ton hydraulic cranes. The pressure in the accumulator will be 1,500 lbs. per square inch.

The blacksmith shop is being equipped with oil furnaces throughout. There will be an overhead system of exhausts, and a blast system for introducing air. Shavings will be removed from the planing mill and cabinet shop by the exhaust system, and carried to the power-house for consumption under several of the boilers.

PUMPING BY ELECTRICITY.*

THE CLARKE AVE. MOTOR.

(Concluded.)

The motor is a 400-h.p., three-phase, 60-cycle, 2 200-volt, 90-amperes induction machine, having 44 poles and therefore a synchronous speed at 60 cycles of approximately 160 revolutions per minute. In order to keep up the power factor with that number of poles a very large machine with a very small air gap or clearance naturally results. The rotor is 13 feet diameter, and the stator 6 feet outside diameter. The clearance between rotor and stator is less than 1-16 inch. The guaranteed power factor at full load is 91½ per cent., full load efficiency 92 per cent., heating limit after 12 hours run 40 deg. C. temperature rise at full load. An overload of 25 per cent. for two hours should not show a temperature rise of more than 50 deg. C. at same efficiency. The above is a very liberal rating on this machine, as another 10 degrees would not be out of the way for regular running, and 550-h.p. could easily be realized at that limit. The machine passed its test satisfactorily. This and its duplicate, are the largest induction motors ever built in point of power, and are much larger in their diametrical dimensions than anything previously at-

* From a paper read before the New England Waterworks Association, by F. H. Pitcher, chief engineer of the Montreal Water and Power Co.