

months of work. For the full reports, fifty-nine in number, made by Metcalf & Eddy, reference may be made to Vol. 3, of the report of the Boston Finance Commission.

While the difficulties of such investigations are many, it is believed that the results recorded represent very conservatively the conditions existing. It is apparent that municipal work done by day labor is in general, under the conditions of to-day, much more expensive than similar work done under the same conditions by contract. It is also apparent that the labor force in city departments where work is done by the day labor system is very inefficient as compared with similar forces employed by contractors, and has, during the last ten or fifteen years, decreased greatly in efficiency, at least in the city of Boston.

There are many causes of the excessive cost of day labor work and of the inefficiency of the day labor forces, all of which may be grouped under the one great evil—the entrance of politics into municipal business. These causes include abnormal rates of pay, the granting of holidays and half-holidays, the employment of aged and physically incompetent laborers, absence of discipline, a lack of incentive, and the inexperience of those in executive positions. It would further appear that the number of men growing old in the service of the city, who were at the time of their original employment young and vigorous, is not a material cause of inefficiency. On the other hand, the employment of men in city departments who have passed their years of usefulness in the service of other parties, has a demoralizing effect upon the labor forces, and has undoubtedly been the cause of much of the inefficiency noted in municipal day labor forces.

#### **TURBINE PUMP IN THE LOW LEVEL PUMPING STATION, MONTREAL, QUE.**

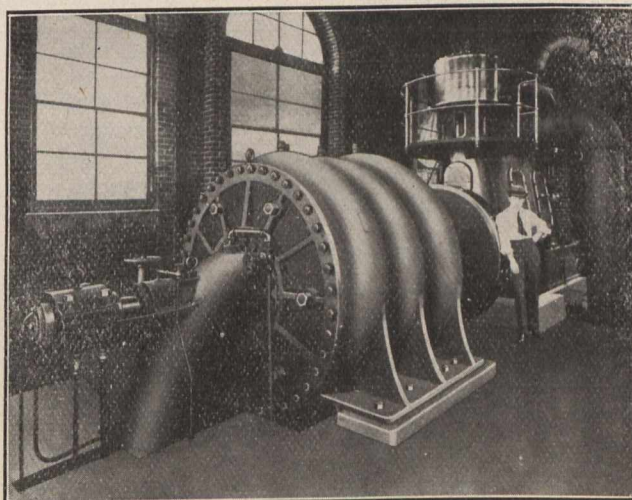
The performance of the engine-driven turbine pump at the Low Level Station of the Montreal waterworks is worthy of the attention of waterworks and hydraulic engineers, because hitherto it was considered impossible to deliver water with commercial success against high heads by these means. The plant consists of a Worthington three-stage turbine pump designed and built by The John McDougall Caledonian Iron Works Company, Limited, and a Bellis & Morcom 750 h.p. triple expansion steam engine. The contract provided that the unit should have a duty of 100,000,000 foot pounds for each 1,000 lbs. of steam at 100° superheat, allowance being made for all heat returned to the boilers.

An official test, the details of which are given below, was conducted on November 19th and 20th, 1909, by R. J. Durley, Professor of Civil Engineering at McGill University, who found that the duty of the pump and engine was equivalent to 110,151,000 ft. lbs. per 1,000 lbs. of steam superheated 100°. No indicator cards were taken officially, as they had no bearing on the contract, but they were taken unofficially by the representative of the engine builder. The indicated horse-power on these cards showed that the total overall efficiency was 70 per cent. This included not only pump losses and engine losses, but the power required to drive the air and feed pumps, which were attached to the main engine, and for which no allowance has been made.

Although the duty obtained does not compare favorably with the best practice in high duty pumping engines, the contract price of the plant was only one-third of the price asked for vertical triple expansion pumping engines of equal capacity. Considered as a commercial proposition, it will be found that the interest on this difference, added to the difference in the cost of engine house and foundations, will more than make up for the extra fuel consumption.

The first test on June 23rd, 1909, was conducted by Messrs. Thomas Hall, M. E., on behalf of the City, and W. Clinton Brown, M. E., on behalf of the builders. It showed that the pump and engine reached a duty of 113,302,278 ft. lbs. The superheat was 166° and the city authorities objected to the result on that ground, notwithstanding the fact that the boiler room was under their own control and that they were responsible for the high superheat. The second test, on August 4th, 1909, gave a duty of 108,053,861 ft. lbs. at an average of 107° superheat. Having the details of both tests before them, Messrs. Hall and Brown calculated that, with the superheat at 100°, this would be equivalent to 107,588,268 ft. lbs. The chairman of the water committee thought however, that this duty was too high and insisted upon a third test. This time, R. J. Durley, Professor of Civil Engineering at McGill University, had charge of the test. He was assisted by Mr. Hall, but the builders were not represented and took no part in it. Professor Durley's test on November 19th and 20th, 1909, showed a total duty of 113,557,732 ft. lbs. at 119.6° superheat, which he advised was equivalent to 110,151,000 ft. lbs. at 100° superheat.

The reason for the variation in the results is that the city's tests took place in summer when the feed water was warm and Professor Durley's test took place late in the fall when the water was very cold, and the colder the water the greater the value of the return heat. If allowance is made for the variation in superheat and feed water, it will be found that the three tests check up so closely as to leave no probability of error, and that the high duty shown was really attained.



Engine driven turbine pump, built by the John McDougall Caledonian Iron Works Company, in low level station, Montreal, Canada.

As already stated, the contract provided that the pump and engine should have a duty of 100,000,000 ft. lbs. for each 1,000 lbs. of steam at 100° superheat. It further provided for a forfeit of \$2,000 for each 1,000,000 ft. lbs. below the stipulated duty or a bonus of \$2,000 for each 1,000,000 ft. lbs. above the stipulated duty, but this bonus was limited to a duty of 105,000,000 ft. lbs. In consequence of the results shown by these different tests the city paid a bonus of \$10,000 to The John McDougall Caledonian Iron Works Co., Limited.

#### **Method of Carrying Out Test**

The air pump discharge was weighed, the scales used having been calibrated and found correct. The weighing was checked at frequent intervals throughout the trial. It was not possible to test the tightness of the condenser, but as any leak there would go against the engine, and none was