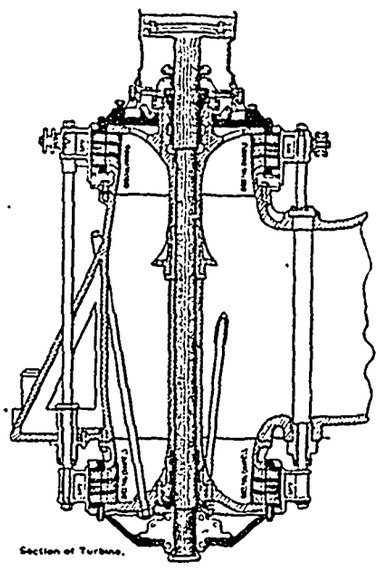
States known to the writer has just been started by the Philadelphia Street Railway Company in their new power house. Without the use of hot air to feed their furnaces, they claim an economy of over 27 per cent. in fuel. They also claim that the plant did not cost so much as a chimney would have done and occupies less space on the ground. However, most of their plant was put in over their boilers where a chimney certainly could not have been erected. With a self-feeding apparatus for the coal, and hot air supplied to the furnaces, it is doubtful if any visible smoke would be discharged into the air. If six tons of coal can be made to do the work that ten tons is doing now, and get rid of the smoke nuisance at the same time, the street railway and electrical companies which are now so busy putting in large boiler plants all over the continent should find time to look into the matter. No patents have been taken out on the invention, or rather combination, for the whole plant is only a combination of Green's economizer and other well known inventions on which the patents have long ago expired.

THE CATARACT CONSTRUCTION CO.'S TURBINE.

Last month we gave a description of the work undertaken by the Cataract Construction Co. at Niagara Falls, and now we are able to give some diagrams illustrating the great turbine, for which we are indebted to *Power*. This wheel has thirty-two movable blades, the directing passages being formed by thirty-six deflecting plates. The shaft is vertical, bringing the wheels proper into a horizontal position, one at the top and one at the bottom of each case. Gates, controlled by the governor, are made to uncover more or less of the discharge, opening according as more or less power is required. It is expected that the governing mechanism will control the speed under ordinary variations of load within a variation of less than half of one per cent., and when one-quarter of the entire load is thrown off at once the variation of speed is calculated at not more than 3 per cent. To maintain the efficiency of the wheel on less



SECTION OF TURBINE.

than full gate opening, the discharge passages and the blades are divided vertically into three compartments, so that when the gate is only one-third open, for instance, the wheel is in the same condition as to direction and velocity of water discharged upon the blades as though the gate were completely open.

One serious engineering problem to be met in this installation was that of supporting the weight of the long vertical shaft and the attached portions of the dynamo, amounting to about 152,000 pounds, and the enormous downward pressure of the column of water in the penstock. This is solved in this design by closing the bottom of the casing so that the water cannot act downward upon any of the parts attached to the shaft, while in the upper end of the casing are apertures through which the water can act upon the under side of the disc, carrying the movable blades of the upper turbine, and relieve the bearings of the weight of the shaft. In this way the weight of the water column is sustained by the stationary portions, which can be braced and supported for the purpose, and the pressure due to the head made to act upward for supporting the weight of the revolving shaft, which is thus nearly in the condition of a shaft spinning upon the water. The area involved is so proportioned that when the wheels are lightly loaded the upward pressure will be some 2,000 pounds in excess of the weight of the shaft, and when the wheels are running at full gait about the same amount less than the weight of the shaft, on account of the lesser pressure in the casing. This variation in pressure and direction is taken care of by a thrust bearing shown in section in the detail drawings.

The shaft consists of a steel shell about a foot in diameter, with smaller solid portions in the journals, which require to be of less frequency on account of the stiffness due to the large diameter of the hollow shaft. The latter is of rolled steel tubing without any visible vertical seam. No fly-wheel is required, sufficient momentum and inertia being furnished by the heavy fields of the dynamo which are carried upon the shaft.

HALF PLAN OF TURBINE.

CONCRETE-IRON ARCHES AND SLABS.

For some time past considerable attention has been attracted to various methods of combining iron and concrete for arches, floors, etc. The object of the iron is to make up for the low tensile strength of the concrete, which is much below its crushing strength. Repeated experiments have shown that the iron and concrete work very well together. They have much the same coefficient of expansion by heat, and hence the iron has no great tendency to separate from the concrete in which it is imbedded, and there is, moreover, considerable adhesion between the two, amounting to as much as 500 lb. per square inch of the surface in contact. The system seems to have originated in France, where a market gardener formed large flower-pots of concrete with iron netting imbedded in them. Pipes were afterwards formed in the same way, and finally arches and beams. Since then the matter has been taken up by various experimenters in Belgium and elsewhere, who have adopted different plans for the iron stiffening. Particulars of tests of concrete joists stiffened by $\frac{1}{4}$ in. iron rods were given in our issue of May 1, 1891, and showed a remarkable resistance when the newness of the concrete is taken into account. Sebastian Gruber, of Munich, gives London *Engineering* particulars of somewhat similar tests made at the Munich Mekanisch-Technische Laboratorium, of a concrete arch and a concrete plate, in which the stiffening bars were riveted-together into a sort of lattice-work, as shown in Fig. 1. This lattice-work is