daily for six days in the week, while the average removal of organic matter (albuminoid ammonia), and bacteria was 95 and 98 per cent., respectively. In 1894 Col. Waring instituted experiments upon sewage purification aided by forced aeration, at Newport, R. I. These were continued during five months from May till October, and the results set forth in a pamphlet which also contains a synopsis of the chemical work and investigation carried out simultaneously by Geo. W. Ralfe, A. M. (Harvard). The Willow Grove Park (15 miles from Philadelphia) sewage disposal plant was constructed shortly after upon the principles evolved by the Newport experiments. It is simply composed of a set of strainer and aerator beds, one-eighth acre in extent in all. The sewage applied daily is assumed to be from 60,000 to 100,000 gallons. The resulting effluent at date of my visit on 6th Sept. was very good, clean and odorless, and the most of it was in daily use for sprinkling the lawns and roadways at Willow Grove. I found, however, that the receiving well was clogged with hard compact sewage to the depth of 4 feet. This will have to be removed eventually by hand, as it cannot be pumped up. The man in charge informed me that the plant had been one year in operation, and that the strainer beds have to be overhauled every season (six months), and the material washed and returned to its place. This, he says, occupies three men during a week.

As to the conclusions arrived at by the chemist in charge during Col. Waring's Newport experiments, they indicate that a strainer tank can remove 40 per cent. of the nitrogenous matter in ordinary sewage, if this sewage, roughly strained and free from mud, is applied continuously, at a minimum rate of 3,000,000 gallons daily per acre; and that an aerator bed one acre in extent, with nitrification properly established, and proper manipulation, will remove 95 per cent. of the organic nitrogen of a strainer effluent, applied at a rate of at least 800,000 gallons daily. It will do so for an indefinite period, under, of course, proper conditions of working. This means that ¼ acre of strainers, and 1 acre of aerators (1¼ acre in all), will suffice for the treatment of the sewage of 10,000 people at the rate of 80 gallons per capita. I have been unable to obtain the cost of the Willow Grove plant, now about one year in operation, which includes the pump house, pump, blower, masonry and concrete work, filtering material, and all accessories; hence, it is difficult, may impossible, to compare it in the large and practical way with other methods which will be discussed further on; but, from my own actual observation, and the statements of the man in charge, I am of the opinion that the conclusions reached by the experimenters are quite in accordance with the actual working of this very valuable system of artificially aerated bacterial filters as claimed by the inventor, whose theory regarding "Bacterial oxidation" of sewage is pretty generally understood.

Reverting to the Massachusetts State Board of Health experiments with coke, I now quote an extract from page 480, report 1896, which sums up the immense value of this material as an aid to sewage purification, and especially as a sludge retainer: "When Coke Breeze can be obtained, and the sewage given a preliminary treatment before sand filtration, by being passed through this breeze at a high rate in gallons daily per acre, the organic matters can be removed from the entire body of the sewage as completely as chemical precipitation removes them from the main body of the sewage. There is no resulting sludge liquor from this coke straining process, and the clogged coke can be removed from time to time and burned, the sludge being of course held by, and burned with it.

"During some of the experiments 13.8 cubic yards of coke per million gallons of sewage filtered were removed, dried and could have been used as ordinary fuel. By straining through coke we have removed during 1895, 54 per cent of the sludge (albuminoid ammonia) of the sewage. The latter has been strained at an average rate of one million gallons per acre daily, and the coke strainer contained from 6 to 8 inches in depth of coke. The coke is known as breeze (screenings from ordinary coke). At the Lawrence Gas Works where it is obtained, it is used under the boilers, and estimated to be worth one-fourth as much as the steam coal, or, from $1 to $1.25 per ton; the amount used has been 10 cubic yards per million gallons of sewage strained, and, as a ton of coke occupies about 2.3 cubic yards, the sewage has been purified, to the extent given, at a cost for coke of $5.43 per million gallons of sewage strained, estimating the coke to be worth $1.25 per ton. By this method we remove the sludge from the entire body of liquid, and get rid of the concentrated sludge liquor which results from sedimentation, or any chemical precipitation process, and, it seems that the coke is as valuable for combustion after use in the strainer as before."

I may add that in the coke filter experiments of 1895, the removal of organic matter and bacteria, at a rate of 260,000 gallons per acre daily, for 6 days in the week, was 95 and 98 per cent., respectively. Now, sludge resulting from sedimentation or chemical precipitation contains 90 per cent. of water, the latter being separated from the solids by a most expensive and dirty method of pressing. Even then, the resulting cake contains 50 per cent of water, and, using the lime and alum precipitation process (probably the best), the pressed sludge will amount to eight tons per million gallons treated, equal to 40 tons as swept from the tanks. As one-half of the pressed cake consists of water, the dry solids are equal to 4 tons per million gallons of sewage. In the Lawrence experiments above quoted, the sludge was removed by burning at a cost of $5.43 for coke per million gallons treated, while, in any chemical process, 8 tons of semi-fluid, evil-smelling cake are produced at a heavy expense for filter presses, cloth and labor, and afterwards the problem of getting rid of this foul asset has to be faced, since it is utterly futile to think of selling this cake to farmers, and the further expense of carting it away must undoubtedly be taken into consideration. In England the cost of producing sludge cake may be taken, at the majority of works (according to Santo Crisp), at 2s. 6d. sterling per ton; and the same authority states that although it is sometimes sold for a trifle, or taken away by farmers, the latter are as often paid to remove it. In the vicinity of large cities it has been dug into the ground, or spread out to dry, but, however, handled or disposed of, it is an undoubted nuisance; hence any method of sewage disposal whereby the sludge difficulty can be eliminated entirely, must recommend itself to practical men. In estimating the cost of sludge removed (per million gallons of sewage treated), by coke strainers, as against sludge pressing into cake, we have roughly, taking the Lawrence prices of materials used:

BY COKE STRAINERS.

Say 4½ tons of coke at $1.25	$5.62

BY SLUDGE PRESSING.

Pressing 8 tons sludge cake at 60c	$4.80
Carting away 8 tons, ditto	....
1,000 lbs. crude alum at $25 per ton	12.50
1,000 lbs. slaked lime at $9 per ton	4.50
Required for precipitation of one million gallons of sewage	$21.80

Therefore, is there much to be said in favor of coke as a strainer, as compared with any precipitation process; while the cost of buildings, tanks, and the other accessories required in the last named process, will certainly counterbalance that of a furnace, drying ovens and chimney necessary for clogged coke combustion. The Pennsylvania Sanitation Company of Philadelphia have taken advantage of the foregoing facts as regards the valuable properties of coke breeze and aerated sand and gravel filters, in their sewage disposal plant erected at Reading, Penn., which has been in very successful operation for the last year and a half.

The population of Reading is about 80,000, as I am informed, but so far only about 25,000 people contribute to the sewerage system. The average daily flow of sewage treated by the Philadelphia Sanitation Co.'s works during August last was 1,586,463 gallons. These works comprise a very handsome pumping station situated at 6th and Canal streets. This station includes two large receiving reservoirs in which the coke strainers are placed, two large pumps of 5,000,000 gallons capacity each, three 65 h.p. boilers, drying ovens and tall chimney stack, which ventilates the receiving chambers. A force main 7,200 feet in length conducts the strained sewage along the banks of the Schuylkill River to the filter beds. These filter beds comprise an area of 25,000 square feet, or fifty-seven hundredths of an acre. One-half of this area is supported by an iron structure, and is at a level 8 feet 6 inches higher than the lower half. The upper beds are divided up into ten compartments, each 25 feet by 50 feet. Iron pipes resting upon beams and girders, supported by iron columns, carry the filtering materials which con-