awaited some authoritative affirmation to set against the records of early mistakes, misapplications and failures. The proper treatment of steel had now been thoroughly investigated, and the circumstances under which the metal was damaged, by punching holes and other manipulation, were well understood. But there was also needed some ready means of verifying quality. This was far more necessary in steel than in iron, because in the latter the range within which strength might vary was only one-sixth, whereas steel had a much wider range. Again, the mere fact that iron had been rolled into shape insured a certain minimum of quality, while if steel chanced to be bad it might be one-half weaker than was wanted. An authoritative brand or hall-mark seemed necessary, if steel was to be universally accepted, and the author suggested that some mark should be adopted, as denoting quality and kind, the addition of the particular trade-mark of each maker serving as a warranty. But in order to encourage a further use of steel, the Board of Trade rules should be altered. While a certain minimum of strength and ductility might be demanded, the present limits to the maximum straining should be amended so that, instead of 6½ tons per square inch, 8 tons might be allowed, an increase amply justified by the experience acquired during the last few years. If this was done the greater demand would almost certainly have the effect of bringing the price nearer to that of iron, as had been the case with rails. The author set forth the present rules of the English Admiralty and Lloyd's in regard to steel for ships, and directed attention to the different rules of the French Admiralty, to exemplify the alterations which he proposed. As it was by means of a Royal Commission that the present strains on steel were permitted it was time that another commission should be appointed to inquire into the facts more recently acquired and to grant more liberal rules for the future. With an extension of the present limit of 6½ tons there would be such a demand as would lead to improvements in the manufacture, increase the output and reduce the price of steel. The whole calculation would then be altered, and when steel might not only be worked to 8 tons strain per square inch, but the difference in price over iron was less than it was now with 6½ tons, then, but not till then, would the era of steel structures have arrived.

LIVERPOOL ENGINEERING SOCIETY, ROYAL INSTITUTION, COLQUITT STREET.

At a meeting of the above society held on Wednesday evening, March 1, Mr. C. S. Pain, Vice-President, in the chair, a paper on "Heating and Ventilation" was read by Mr. W. E. Mills.

The author, in introducing his subject, pointed out the necessity that existed for a scientific study of its principles and laws, as evidenced by the fact that upwards of 120,000 deaths occur annually in the United Kingdom from what may be called preventible diseases, a large proportion being from consumption, bronchitis, etc., and mainly due from neglect or ignorance of the laws of ventilation.

The earliest means of heating—viz., by a pan of charcoal, or live coals, afterward improved by being placed in a box or grate—was then described, and this arrangement with some modifications in form, but none in principle, was shown to be the ordinary household fire-grate of the present day.

Large buildings requiring special appliances for economizing and distributing the heat produced by combustion, stoves were introduced, which for heating answered well, but by consuming the oxygen of the air, destroyed the vital principle, and from a ventilating point of view were consequently inadmissible.

Stoves and fire-grates shared alike the disadvantages of being too local in their influence. Where heat was required to be conveyed to a distance, some other means of doing so than by a stove or grate was imperative. Hot water naturally suggested itself, and the "low pressure" and "high pressure" systems were described. Neither were to be taken as satisfactory, unless provision were made for introducing fresh air under the pipes, so as to fulfill the requirements of proper ventilation.

The author pointed out that it was a great fallacy to suppose that air to be *fresh* must of necessity be *cold*. All air admitted to a room or building should first be moderately warmed. This could be effected by means of ventilating grates, the principle of which consisted of a chamber formed behind the ordinary fire-grate, supplied with air from the exterior of the building, which, after being warmed, was delivered into the apartment. The principal kinds were the Galton, the Longden, the Boyd and the Mancher, each set of which were briefly described.

Gas stoves the author condemned, as, although convenient, the fumes given off were very deleterious, and a large amount of gas was consumed for very little effective result.

The system patented by Mr. Lewis W. Leeds, of Philadelphia, was next described. Steam was employed as the heating medium, supplied to coils or radiators, of specially formed pipes, the theory being that the proper way to warm a room was by radiation from the floor and walls.

With regard to ventilation, the author showed that it was necessary to change the air of a room several times in each hour, according to the number of occupants, gaslights, etc., allowing for each person 900 cubic feet per hour, for a gaslight 480, and for a fireplace 48,000.

The cause of draughts was then explained, the remedy being to admit a copious supply of fresh air at the lower part of the room, and draw off the foul and vitiated air at the upper.

Pott's Ventilating Cornice and Tobin's Vertical Tubes were then treated of, and their advantages and disadvantages compared.

The author concluded his paper with a few rules as to the proportion of inlet and outlet for ventilating shafts, the amount of radiation from hot-water pipes, and the cooling effect exerted by windows.

An interesting discussion followed the reading of the paper. The Vice-President announced that at the next meeting of the Society, to be held on Wednesday, March 15, a paper on "Paper Machinery," would be read.

THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.

BY J. JAMES R. CROES, M. AM. SOC. C. E.

Continued from page 91.

CCXLVI.—SALEM, OR.

Salem, Oregon, in lat. 44° 56′ N., long. 123° W., is on the east bank of the Willamette River. It possesses a valuable water-power from Mill Creek, which empties into the river near this point.

Settled in 1840, it was incorporated in 1846. Water-works were built by a private company, after the plans and under the superintendence of W. F. Boothby, taking the water from the Willamette River and pumping it 87 ft. by a Blake pump of 18-in. steam and 12-in. water cylinder of 24-in. stroke into a reservoir of stone and timber holding 180,000 gallons.

Distribution is by 6 miles of cast-iron pipe of 6-in. to 3-in. diameter, with 35 fire hydrants, 25 gates and 250 taps. The town pays $1,500 per year for use of hydrants. Service pipes are of galvanized iron. The population in 1880 was 5,009. The daily consumption is 360,000 gallons.

The capital stock is $90,000. The works have cost $50,676.11, including purchase of water-power and opposition works in 1881. There is no debt. The gross receipts have been $54,971.18. The expenses in 1880 were $3,000.92 and the receipts $5,595.11.

W. F. Boothby is President and David Allen Secretary of the Company.

CCXLVII.—PIOCHE.

Pioche, Nevada, is in lat. 37° 50′ N., long. 114° 30′ W., in a cañon of the Cordilleras, 7,000 ft. above sea level. Was settled in 1869.

Water-works were built by a private company in 1872, after plans of George Coffee, taking water from springs and catching it in wooden tanks holding 200,000 gallons, 312 ft. above the town.

Distribution is by sheet-iron pipe, double riveted and coated with asphalte, of which 8 miles are laid, of from 8 to 5-in. diameter, with 20 fire hydrants and 45 taps. The town does not pay for use of water. Service pipes are of gas pipe. The population is about 900 and the daily consumption 10,000 gallons. The works cost $150,000. No further financial statements are given.

R. H. Elam is the Superintendent.

CCXLVIII.—PORT BYRON.

Port Byron, N. Y., in lat. 43° 2′ N., long. 76° 40′ W., at the outlet of Owasco Lake, is in the valley of the Owasco, with hills to east and west from 100 to 75 ft. high.

Settled in 1797, it was incorporated as a village in 1837. Water-works were built by the village in 1872 for fire purposes only, taking the supply from the lake, and pumping by water-power through a 4-in. pipe into a reservoir 150 by 55 ft. and 12 ft. deep, excavated in clay and without lining, and 175 ft. above the village.

A 6-in. pipe connects with the force main near the pump, and extends through the main street. A 4-in. pipe from the reservoir passes through the streets on the west side.

The pipes are of cast iron. About 3 miles are in use, with 24 fire hydrants, 3 gates and 26 taps. The water is not used for drinking or household purposes.

The population in 1880 was 1,250. The consumption is not known. The works cost $10,000, and there is a bonded debt of $3,000 at 6 per cent. interest. Further financial statements are not given.

Charles M. Storms is Water Commissioner.

CCXLIX.—BIG RAPIDS.

Big Rapids, Michigan, in lat. 43° 45′ N., long. 85° 45′ W., is on the Muskegan River, on nearly level ground, the greatest difference of elevation being 35 ft.

It was settled in 1860. Water-works were built by the town in 1871. The supply is taken from the river through a gravel filter crib and pumped directly into the mains by a Holly engine and pumps erected in 1871, and two Blake pumps of 20-in. steam and 16-in. water cylinders, with 24-in. stroke, erected in 1880. The ordinary pressure is 65 lbs., and the fire pressure 100 lbs.

Distribution was at first by wooden pipe, which was unsatisfactory, and was replaced by cast-iron pipe, of which 3¼ miles are in use of from 8-in. to 4-in. diameter, with 25 hydrants, 4 gates and 209 taps. Service pipes are of lead.

The population in 1880 was 3,750. The daily consumption in 1881 was 264,000 gallons.

The works have cost $80,000. Further financial statistics are not given.

George H. Lincoln is the Superintendent.

CCL.—NEW BRUNSWICK.

New Brunswick, New Jersey, in lat. 40° 49′ N., long. 70° 49′ W., is on the Raritan River. The crest of a red shale bluff along the river recedes at the site of the city, forming a gently sloping amphitheatre of about a mile in diameter.

The city was incorporated in 1784. Water-works were built by the city in 1866 after plans of E. Willard Smith, C. E., and under the superintendence of Thomas N. Doughty, C. E., taking the supply from Lawrence's Brook, a stream south of the city, with 43 square miles water-shed. A stone dam 15 ft. high and 184 ft. long creates an impounding reservoir and also furnishes power to a 54-in. American turbine wheel, which drives a 12-in. pump which lifts the water 180 ft. to the distributing reservoir built in excavation and embankment, with two basins each 300 ft. square and 15 ft. deep. A Selden direct acting steam pump with 36-in. steam cylinder and 22-in. plunger has since been added.

Distribution is by wrough-iron and cement pipe and some cast-iron. Twenty miles are in use of from 16 to 4-in. diameter, with 166 fire hydrants, 209 gates, 1,250 taps and 59 meters.

The city contributes $50 per year for each hydrant out of general taxation. Service pipes are of lead and of galvanized iron. The population in 1880 was 17,167 and the daily consumption 1,264,000 gallons.

The works have cost $440,000, and the gross receipts to Dec. 31, 1881, had been $283,454.66.

The expenses in 1880 were $14,901.59, and the receipts $42,754.35. The debt is not given.

The works are managed by a board of water commissioners. M. N. Oviatt was Superintendent prior to January, 1882. A. J. Jones, the Treasurer since 1873, is now Superintendent also.

(TO BE CONTINUED.)

ACKNOWLEDGMENTS.—The receipt of statistics, as follows, is acknowledged with thanks: From B. E. Lehman, superintendent, statistics and water rates of the water-works of South Bethleham, Penna. From O. R. Tyler, superintendent, statistics of the water-works of Torrington, Conn. From A. J. Jones, superintendent, statistics of the water-works of New Brunswick, N. J. From W. H. Glore, superintendent, statisticees of Covington (Ky.) water-works. From Fred E. Hoyt, superintendent and secretary, ninth annual report of East Saginaw (Mich.) water commissioners. From Edwin Darling, superintendent, second annual report of Pawtucket (R. I.) water commissioners. From F. W. Lougee, secretary, statistics and rates of the Petaluma (Cal.) Water-works Co. From C. E. Judson, superintendent and engineer, statistics of the Scranton (Pa.) Water-works Co. From M. Coryell, superintendent, fifth report of Lambertville (N. J.) Water Co. From Robert K. Martin, chief engineer, report of Baltimore water department for 1881. From Louis Le Sage, superintendent, report of the Montreal Water-works for 1881. From Welton & Bonnett, civil engineers, fifteenth report of the Waterbury (Conn.) water commissioners. From A. L. Tompkins, statistics of the water-works of Le Roy, N. Y. From W. S. Bush, superintendent, statistics and water rates of the water-works of Westfield, Mass. From the water commissioners, statistics of the water-works of New Britain, Conn. From W. F. McCue, superintendent, statistics and water rates of the water-works of Ottumwa, Ia. From James B. Simes, president, statistics of the water-works of Downingtown, Pa. From S. S. Graves, superintendent, statistics of the water-works of Geneva, N. Y. From W. E. McClintock, city engineer, report of the city engineer and superintendent of sewers for 1881 of Chelsea, Mass.

CORRECTIONS.—March 11, p. 84, *Middletown*, Conn. The drainage area of the reservoir is 1½ sq. m. The filter wall is a double wall of *stone* filled in with small stone and gravel. March 18, p. 91, *St. Charles*, Mo. The cost of the works *was* $160,000, *not* $80,000 *as erroneously published.*

The circular sent to Tonawanda, N. Y., being returned unclaimed, it is supposed that there are no water-works there.