which built and manages the works has a capital stock of $100,000 and $100,000 of bonds were issued. Under a contract with the city the company was required to set 100 fire plugs at $100 each, and additional ones at $75 each, and to throw from the hydrants eight 1-in. streams simultaneously 100 ft. high. The contract test was complied with.

Frank Schefold, C.E., has been the engineer and superintendent from the beginning.

LXIII.—MONTGOMERY.

Montgomery, Alabama, in lat. 32° 22′ N, long. 86° 27′ W, is on a high bluff on the east bank of the Alabama River. Laid out in 1817, it was made the seat of the State government in 1847.

Water-works were built in 1873, by the Montgomery Water-Works Company, a corporation chartered by the Legislature of Alabama. The works, franchises, etc., were purchased at Chancery sale, July 1, 1880, by Geo. H. Hazlehurst and associates, who reorganized under the present style, "Montgomery Water-Works," with A. J. Lane, President and J. R. Baldwin, Secretary, Treasurer and Superintendent. The water supply is obtained from the Alabama River, pumping directly from the river, except in time of high or muddy water, when the supply is obtained from a filtering gallery, located in the gravel on the river bank. The pumps are Worthington duplex high pressure of nominal capacity of 1,000,000 gals. per 24 hours, which capacity is, however, largely exceeded in practice every day. Steam is supplied ordinarily by one battery of three boilers, each 44 in. × 22 ft. with double flues 15 in. diameter. A reserve battery of two smaller boilers is also used occasionally. Water is forced through a cast iron main 10 in. diameter 1⅓ miles to a reservoir 184 ft. above mean low water in the river, and of an average elevation of 100 ft. above the business part of the town. The various branches leave the pumping main before it enters the reservoir, and in effect, when the pumps are in operation, the consumers are supplied directly from the pumps, the surplus going into the reservoir. This has a storage capacity of about 4,000,000 gallons, is an earth-work structure with outer slopes of 1½ to 1, and inner slopes of 2 to 1, with a promenade on top of the bank 20 ft. wide. There are ten miles of distributing pipes ranging from 10 in. to 3 in., all cast iron, supplying 103 fire hydrants and 550 private consumers. The population of the city in 1880 was 16,714. The city lies between the pumps and the reservoir. J. R. Baldwin is the superintendent.

LXIV.—NORTHAMPTON.

Northampton, Massachusetts, in lat. 42° 19′ N., long. 72° 42′ W., is on the Connecticut River. The main portion is situated on elevated ground, a mile from the river, with commanding eminences back of it. It was settled in 1654.

Water-works were built by the city in 1870–1, after the plans and under the superintendence of Nelson J. Welton and William W. Bonnet, civil engineers.

The supply is taken from Roberts' Meadow Brook, a mountain stream flowing through a rough granite region. Its drainage area is not known.

The water is impounded by an earth dam 17 ft. high at centre, with heart wall of puddle 12 ft. wide at foundation and 6ft. wide at top.

The upper slope is 2 to 1, and is paved with stone.

The waste-way was cut through an adjoining hill The earth banks washed to such an extent that they were lined with stone, the bank cut through to the bottom of the reservoir and a masonry overfall built.

On the upper slope of the dam is a brick gate chamber from which a 24-in. waste and a 16-in. supply pipe pass through the dam. The flow line is 240 ft. above the town.

The supply main passes through the villages of Leeds and Florence, which are supplied with water. From the reservoir to Florence, 14,471 ft., the pipe is 16 in. in diameter; from Florence to Northampton, 12,973 ft., it is 12 in. in diameter.

All pipes are of cast iron. In 1880, there were 22 miles of pipe and 125 hydrants. The population of Northampton in 1880 was 12,172.

The income had exceeded the expenditures and interest up to Feb. 1, 1880, by $3,085.11, and the entire cost of the works to the same date had been $209,322.84.

In 1875 the crossing of the 16-in. pipe under the Mill River was washed out by the disaster at the Williamsburg reservoir. During the relaying of the pipe a supply was had by a 10-in. pipe laid across a temporary bridge.

The works are managed by a Board of Water Commissioners. M. M. French was superintendent in 1873; in 1875 J. M. Clark was appointed, and is the present incumbent.

LXV.—COLUMBUS.

Columbus, Ohio, is in lat. 39° 57′ N., long. 83° 3′ W., on the Scioto River. The site is nearly level, and the city comprises 10.6 sq. miles. Founded in 1812, the water supply was from wells until 1870, when, its population being 31,274, the city built water-works, taking water from a well on the bank of the Olentangy River, a tributary of the Scioto.

In 1873-4 a brick conduit 370 ft. long, of elliptical form, 3×4 ft., 27 ft. below the surface of the ground and 13 ft. below the river was built from the well to filter basins. The lower basin was excavated to 13 ft. below the river, with slopes of 1 to 1, protected with rip-rap. The bottom area was 14,294 sq. ft. Its supply was drawn from the ground water and from the upper basin, of 8,742 sq. ft. surface, which was excavated to 7 ft. below low water in the river. Along the side of this basin adjoining the river and 7 ft. below the surface a gallery 18×21 in. was built, emptying into the lower basin. From it 14 smaller galleries radiated at 4.5 ft. below the surface, under the upper basin, the bottom of which was covered with graduated gravel and sand, the coarser stones at the bottom and 7 in. of fine sand on top. A 12-in. pipe admitted water from the river to this basin. The depth of water on the sand was 2.5 ft. at low stages of the river. This filtering arrangement soon proved to be of insufficient size. The basin, galleries and wells yielded about one million gallons per day, and the filter bed could not filter more than 500,000 gallons per day.

In 1877 to 1879 a natural filter gallery was extended along the river bank from the pumping works. The conduit is elliptical. 36 × 42 in., constructed of specially molded arch brick. Each alternate course of brick in the lower half has openings left in it to admit the ground water. The grade varies, but is generally about 28 ft. below the surface, or 10 ft. below low water in the river. Its construction was carried on in an open cut, through varying strata of alluvial deposit, quicksand and gravel. Except in good gravel the gallery is impervious to water. Its total length is 5,715 ft., passing under the Olentangy River, and at present terminating at a bend in the Scioto River, where a well with gates and inlet pipe allows water to be drawn from the river in emergencies.

Water is pumped directly into the mains by Holly engines.

The first pumping machinery consisted of a Holly 4-cylinder engine driving a set of "gang pumps" and rotary pumps.

In 1874 another Holly engine was erected with four 12-in. pumps, of a nominal capacity of 6,000,000 gallons per day, when working under 60 lbs. water pressure.

In 1876 the gang and rotary pumps were removed and a 4-cylinder double-action pump of 12 in. in diameter and 27-in. stroke was put in. These pumps are geared to a shaft driven by the engine of the former gang pumps.

The Scioto River is crossed by a 10-in. wrought-iron pipe 426 ft. long, with ball and socket joints. In 1878 an ice gorge formed in the river and broke the pipe in the middle of a section.

When relaid a trench 30 in. deep was dredged in the river bottom to receive the pipe.

The distribution is by cast-iron pipe, of which 39.5 miles were laid on March 31, 1880, 14 miles of them of 4-in. diameter. There were then in use 319 fire hydrants, 2,156 taps and 534 meters.

In 1880 the population was 51,665 and the daily consumption 2,159,827 gallons.

The cost of the works to March 31, 1880, including maintenance and repairs, was $884,867.27, and the total receipts had been $291,047.95.

The receipts for the year 1880 from water rents were $44, 572.47, and the cost of maintenance, $19,044.92.

The works are managed by a board of three trustees. C. M. Ridgway was superintendent for 1871-2. Frank Doherty has been superintendent since 1872.

LXVI.—MANKATO.

Mankato, Minnesota, is on the south bank of the Minnesota River, 86 miles from St. Paul. The business portion of the city is on a plateau about 30 ft. above ordinary stages of the river, back of which rise bluffs.

In 1875 a well 5 in. in diameter was sunk 2,200 ft. on the bluff, at a cost of $15,000. The water rose to within 80 ft. of the surface. An attempt was made to pump it to the surface, but the project was soon abandoned.

In 1879 R. D. Hubbard & Co. proposed to pump all the water needed by the city for fire protection, flushing gutters and street sprinkling for twenty-five hundred dollars per annum, and also what would be used by private takers at actual cost of pumping, the water to be taken from the Minnesota River, where it would necessarily be impregnated for a portion of the year with the city sewage. This offer was accepted, and fifteen thousand dollars in bonds issued for laying mains. Plans and specifications were prepared by M. B. Haynes, City Engineer, and a contract was made.

The contractors furnished and laid 58 ft. of 12-in. pipe, 1,933 ft. of 10-in. pipe, 1,705 ft. of 8-in. pipe, 5,400 ft. of 6-in. pipe and 4,965 ft. of 4-in. pipe, and also placed 30 hydrants. R. D. Hubbard & Co. had previously agreed to lay 467 ft. of 12-in. conduit pipe and erect a temporary crib at the river bank. Water is pumped directly into the mains by one Knowles pump, 12-in. water cylinder, 24-in. stroke and capable of throwing 1,200 gallons per minute. Total cost of the works to the city was $16,047.67.

The water is used to a limited extent by private takers. The works are under the care of the city engineer, supervised by a committee of the Common Council. A constant pressure of 40 pounds is maintained, and this, upon alarm, is instantly increased to fire pressure.

The present system is regarded as temporary.

(TO BE CONTINUED.)

Readers will please make the following corrections:

Aug. 6, p. 311, *Terre Haute*, second sentence, for *above*, read *a town*; fourth paragraph, for *Clapp & Sons*, read *Clapp & Jones*.

P. 312. *Kalamazoo*, fourth paragraph, for *Astell's*, read *Axtell's*.

P. 313, last column, for *Phineas Ball*, read *Phinehas Ball*.

We acknowledge the receipt of the following: From E.C.Boynton, Supt. Newburgh, N. Y., Water Works,11th,12th,13th,14th and 15th Annual Reports of the Board of Water Commissioners.; from John