a large quantity of the sand accumulations. From the northern end of this bank, a viaduct was to run out in a north-easterly direction 3,000 ft., into six fathoms of water at low tide. It was to be formed of wrought-iron piles, placed in bays 30 ft. apart, securely braced together, and supporting a deck of wrought-iron girders, with a plated floor carrying the road surface on which rails would be laid in the usual manner and connected with the system of existing railways. The viaduct would present no obstruction to the ways. The viaduct would present no obstruction to the sand travel, and therefore cause no diminution of the depth of water. At the outer end a breakwater was to be constructed of large concrete blocks, founded on a substratum of rubble, carried down to a sufficient depth to prevent disturbance by wave action. The cost of the work would be about £950,000.

The works for an improved supply of water for Liverpool were making rapid progress. The water was to be impounded from the watershed of the river Vyrnwy, in North Wales, a distance of 67½ miles from the Prescot reservoirs, to which it was to be brought partly by aqueduct and partly in tunnels and pipes. The area of the watershed was 17,513 acres. The upper waters of the Vyrnwy were to be impounded in the valley of the river by a dam, which would collect the waters of the river into a reservoir having an area of 1,115 acres. Manchester recently obtained powers for an additional supply of water from Thirlmere. All were agreed that a supply of pure water was one of the most important means of maintaining the health of large towns, and it had also come to be admitted that it had an important influence on their moral condition. It would be well, therefore, if London would seek to emulate the northern cities in supplying its population with pure water.

The old Eddystone lighthouse, completed in 1759, had always been an object of peculiar interest to the nation. It was with a feeling akin to personal regret that the public learned for the first time in 1877 that Smeaton's work was doomed; but it was a source of satisfaction and consolation that nothing in the design or construction of the tower itself conduced to the necessity for replacing it; but the rock upon which it was been reared had not been so enduring. The new tower was 130 ft. high above high water, or 58 feet higher than the old tower, and nearly five times the quantity of stone was used in its construction. Smeaton's tower contained only four rooms; that of Sir James Douglass nine, of larger and loftier proportions. It had cost £78,000, and had been completed in three and a half years.

Since the application of electric light at the South Foreland lighthouse in December, 1858, considerable progress had been made with all the luminaries applied to lighthouses. At the above date, the standard intensity of the first-order oil-light was 230 candle-units, and the intensity of the most powerful electric light was about 670 candle-units. Recently at the Eddystone lighthouse two oil lamps, each of 720 candle-units, had been adopted. This intensity would shortly be considerably exceeded. With electric light, a focal intensity of about 10,000 candle-units was applied at the Lizard, and arrangements were being made by the Trinity House for practically testing the merits of an electric light of 60,000 candle-units intensity. With coal-gas light great progress had been made since 1865 by Mr. John Wigham, of Dublin. In the latest development of his system four burners were employed, each of 1,250 candle-units intensity.

Mr. Brunlees then briefly referred to the want of railway communication in many productive countries. The immense population of China would derive great advantages from the construction of railways. It had been said that the objection of the Chinese proceeded chiefly from the fear of introducing foreigners in any considerable number. Chinese statesmen, even those most liberal and enlightened, at one time believed that railways were not adapted to the circumstances of China. They had recently formed a different opinion. An official memorial had been drawn up by one important government officer, and favorably reported on to the Government by another high official, suggesting and recommending the construction of four important trunk lines, and no doubt if these were once executed many more would follow.

In India somewhat more than 900 miles of railway were in course of construction, including three bridges of more than ordinary importance. When the works now in progress were completed, India would have nearly 12,000 miles of railway open for traffic.

In New Zealand the length of railway in various stages of progress during the year ended 31st March last, was 284 miles, and 1,833 miles were then open for traffic, and an additional expenditure of £1,650,000 had been ordered. In Queensland, only a few miles appeared to be under construction; but an extensive system of railways was under the consideration of the government. In South Australia considerable progress had been made in railway building, and this might also be said of Victoria and New South Wales, where there were 342 miles under construction. He regretted that the Australian colonies had not adopted the same gauge for their lines. With the disadvantages which had arisen in England, in India and in America, from a break of gauge, and from the great advantages which Western and Central Europe had derived from a uniform gauge, it might have been thought prudent on the part of the Australian colonies to have accepted the experience of older communities.

In Canada, 2,910 miles of railway were under construction; and in the United States some 11,000 miles had been constructed during the last year. In the United States and in Canada the tendency was toward uniformity of gauge.

The undue neglect of the inland navigation of this country was a subject which deserved the attention of the engineer. For coarse goods a slower conveyance than the goods train might be endured in consideration of its greater cheapness. But to be more extensively useful it must be something between the present speed of the canal-boat and the goods train, with the punctuality of the latter.

Mr. Brunlees then drew attention to the fact that the trained engineer was a comparatively modern creation. Until little more than a hundred years ago Great Britain contained hardly a canal or a passable high road; and two centuries ago it was necessary to send to Holland for an engineer to build a sea-wall.

A Rivers Conservancy and Flood Prevention Act was greatly needed. Private interests of the most insignificant character were suffered to interfere with or prevent the execution of plans which would be of manifest advantage to large popula tions. To carry out any local or general public improvement, private persons must be organized into public bodies, and appeal must be made to the cumbrous and costly machinery of parliamentary legislation in every individual case. There were signs that this ancient system, suitable enough for the rate of progress of public works half a century ago, but unsuited to the rapid march of improvement in our time, would before long be modified and improved.

During recent times of depression, fear had been expressed that the profession was too full, that the work of engineers had been completed. But these fears were vain. So long as capital accumulated in this country, it must be expended in some productive way at home or abroad. Judiciously planned public works were always productive, and the men who found the means would appoint the agents for carrying out the works. Not only were public works, including many new or larger harbors and docks, required at home; not only were new countries of vast extent and enormous resources being gradually laid open to the operations of the engineer, but a greater diversity of employment was offered to him. It was impossible to say to what uses the comparatively new power of electricity might be put, but it must play an important part in the social industrial economy of the age.

THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.

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

(*Continued from page* 52.)

CCCCLXXXII.—BROCKTON.

Brockton, Massachusetts, in lat. 42° 5′ N., long. 71° W., is on the Salisbury brook, on undulating ground.

Settled in 1700, it was made a town under the name of North Bridgewater in 1821. The name was changed to Brockton in 1874, and it was incorporated a city in 1881.

Water-works were built by the town in 1870, for fire protection, pumping water from the river by a No. 7 Knowles pump, into a small reservoir, and distributed through about half a mile of 6-in. and 4-in. pipe, with 7 hydrants.

In 1877 the pipe system was extended by the laying of 2¼ miles of iron pipe of from 16 to 6-in. diameter.

In 1880–81 the town built works for a supply of water for all purposes after plans of Phinehas Ball, C. E., taking the supply from a storage reservoir constructed by impounding Salisbury brook about 3 miles from the city by an earthen dam 25 feet high and 1,500 ft. long, with a heart wall of rubble stone laid in cement, and with the upper portion of the water face paved with stone. A portion of the bottom of the reservoir was prepared for a filtering area by laying 4-in. drain tiles, 30-ins. below the surface and 8 ft. apart. The area so prepared is 55,000 square feet, and it is 750 ft. from the dam to a chamber in which a conduit 3½ feet wide and four feet high, the side walls and arch built of rubble stone and concrete, is to convey the water. This filter has not been used as yet. The reservoir is from 18 to 122 ft. above the city, to which the water is conveyed in a cement-lined wrought-iron pipe of 24 in. and 20 in. diameter.

Distribution in the city is by 9 miles of pipe, of from 16 to 4 in. diameter; 6½ miles is of cement-lined wrought-iron. In December 1881 there were 127 fire hydrants, 128 gates, 385 taps and 66 meters. The city contributes $25 per year for each fire hydrant. Service pipes are of wrought-iron.

The population in 1880 was 13,608. The daily consumption is not known.

The works have cost $203,915.47 and the bonded debt is $200,000 at 4 and 5 per cent. interest.

The expenses in 1881 were $1,902.24 and the receipts $3,618.51.

The works are managed by three commissioners. W. W. Cross is chairman.

CCCCLXXXIII.—WARREN, PA.

Warren, Pennsylvania, in lat. 41° 50′ N., long. 79° 14′ W., is on the Allegheny River, at the mouth of Conewaygo Creek, on hilly ground. The river is 1,200 ft. above sea level and rises about 12 ft. in freshets.

Settled in 1795, it was incorporated as a borough in 1832.

Water-works were built in 1882 by a private company, taking the supply from the Alleghany River and pumping it by two duplex Knowles pumps with 16-in. steam and 10-in. water cylinders of 14 to 20 in. stroke (adjustable) through a 10-in. pipe into a reservoir built in excavation and embankment on a hill half a mile from and 305 ft. above the river. It is 100 by 200 ft. at water surface and 15 ft. deep, containing 1,900,000 gallons.

Distribution is by 12 miles of cast-iron pipes of from 14 to 4 in. diameter, with 49 fire hydrants, 25 gates and 175 taps and 1 meter. The borough pays $1,000 per year for public water.

The population in 1880 was 2,810. The works have just gone into operation. They have cost $60,000. The capital stock of the company is $50,000. E. Meredith is the president and O. C. Allen the secretary and treasurer.

CCCCLXXXIV—CLINTON, MASS.

Clinton, Massachusetts, in lat. 43° 15′ N., long., 71° 30′ W., is in a hilly region on a branch of the Nashua River. It was incorporated as a village in 1850.

Water-works were built by the town in 1882, after plans of M. M. Tidd, C. E., taking the supply from two storage reservoirs receiving the drainage of about 200 acres, formed by earth dams with paved slopes. The water from these reservoirs passes through a valley receiving the drainage of about 500 acres, to another impounding reservoir, whence it is conveyed 6 miles through a 16-in. cast-iron pipe to the distributing reservoir on Burdett Hill in the town, 200 ft. above the river and 28 ft. below the storage reservoir. It is rectangular, with earth banks with masonry heart walls and concrete bottom. It holds 250,000 gallons, is 168 ft. square and 15 ft. deep.

Distribution is by 11 miles of cast-iron pipe of from 16 to 6 in. diameter with 70 fire hydrants, and 64 gates. The works have just gone into operation. Service pipes are of cement-lined wrought-iron.

The population in 1880 was 8,030.

The works have cost $225,000 which is the amount of the bonded debt at 4 per cent. interest.

The works are managed by three commissioners, J. W. Corcoran is the secretary.

CCCCLXXXV.—ST. THOMAS.

St. Thomas, Ontario, in lat. 42° 30′ N., long. 83° 30′ W., on Kettle Creek, is in a very uneven country, seven miles from Lake Erie. It was incorporated a city in 1881.

Water-works were built by the city in 1874, taking the supply from an impounding reservoir formed by a dam across Kettle brook, and pumping directly into the mains by two horizontal steam engines.

Distribution is by 4½ miles of cast-iron pipe, with 40 fire hydrants, 15 gates and 76 taps.

The population is 8,367 and the daily consumption in 1882 was 80,000 gallons. The pumps are 90 ft. below the city level, and the pressure is 110 pounds per square inch.

The works cost $45,000. The debt is not given. The expenses of maintenance in 1882 were $1,300, and the receipts $800.

James A. Bell is the City Engineer.

CCCCLXXXVI.—HAVERHILL.

Haverhill, Massachusetts, in lat. 42° 46′ 43″ N., long. 71° 4′ 54″ W., on the Merrimac River at the head of tide water, is on hilly ground, rising in places to 350 ft. above tide level.

The site was purchased from the Indians in November 1642 and it was incorporated as a town in 1645 and a city in 1870. Water-works were built in 1801 by a private company, taking the supply from ponds near the city which are fed by springs, and distributing the water by bored wooden logs. Round Pond, of 35 acres area and 147 ft. above the river, supplied the town for several years, then Plug Pond or Lake Saltonstall, of 41 acres area and

118 ft. above the river was taken, and in 1870 Kenoza Lake of 260 acres at 100 ft. elevation, the water from which was pumped into Round Pond. In 1878 two Worthington duplex pumps of 2,000,000 gallons daily capacity each, were placed at Kenoza Lake pumping into a stand-pipe 80 ft. in diameter and 50 ft. high at 256 ft. above the river, and several miles of pipe were laid to supply the higher parts of the city. The lower levels are supplied by gravity from Lake Saltonstall and to intermediate levels from Round Pond. There is also a small stone reservoir at 170 feet elevation which supplies the western part of the city.

Distribution is by 25 miles of pipe, a quarter of which is cement-lined wrought iron of 10 to 4 in. diameter, and the rest cast iron of 12 to 4 in. diameter.

There are 75 fire hydrants. The number of taps is not given. Ten meters are in use. The city does not pay for public water. Service pipes of lead and of tarred iron are used. The population in 1880 was 18,472. The daily consumption is 1,250,000 gallons. The works have cost $300,000, and the bonded debt is $65,000. No further financial statistics are given.

Levi C. Wadleigh is President of the Haverhill Aqueduct Company and C. W. Morse the Superintendent.

(TO BE CONTINUED.)

CORRESPONDENCE.

THE PROFITABLE USE OF EXHAUST STEAM.

NEW YORK, Feb. 7, 1883.

EDITOR ENGINEERING NEWS:

The truth expressed in your article of Jan. 29 on "The Profitable Use of Exhaust Steam," that back pressure in engines costs money, is recognized by the New York Steam Company in making its estimates of the cost of steam for power. Should a party make an application for steam to be used for power, and cards be taken which show that the engine is working against a back-pressure, the amount of steam required to overcome it is then determined, and the price given for such extra supply.

A short time since a certain party made application, who was using steam under this disadvantage, and its removal made a difference to him of ten per cent. of the price which he would have been charged if the back-pressure had been allowed to remain. He had been using the exhaust for heating the feed-water for his boiler, and calculation shows that it was actually costing him considerably more for coal than if the back-pressure had been removed and the water heated by other means.

In a more recent case we had to determine the price for which we could furnish steam to another party where the removal of the back-pressure would make a difference in his estimate of twenty per cent. He was using the exhaust for heating his premises as well as the feed-water for the boiler, but there is little doubt that both could have been done more satisfactorily and with a less consumption of coal if the back-pressure had been removed and live steam used instead of exhaust.

A case can be mentioned, though, where the party was using the exhaust steam for heating the feed-water for his boilers in such a manner that he effected a saving of coal amounting to about thirty-two tons in a year.

It can be said that the saving in coal by using the exhaust steam for heating the feed-water is seldom over ten per cent., and is usually much less, owing to the unnecessary back-pressure usually allowed to exist.

Respectfully, E. A. RUDIGER.

ARTESIAN WELL FINISHED.—The Texas & Pacific Railway Company have just finished the artesian well they have been sinking at Toyah for the past month, and it is a grand success in every way. The well is 800 feet deep, flows 7,000 gallons per day, raising the water forty feet above the surface.

KANSAS SOUTHERN & TEXAS R. R.—This road has been chartered in Kansas. Capital $2,250,000. Its incorporators are S. R. Peters, Newton; S. B. Shoemaker, Philadelphia; S. G. Clark, Chicago; F. W. Giles, Topeka; J. H. Richards, Iola; D. J. Fair, Ansel R. Clark, R. M. Saunders, R. F. Rathburn, W. H. Page, C. D. Ulmer, H. L. Menard, Sterling; D. B. Jeffers, McPherson; J. K. Miller and Peter Gosch, Rice County. The line to be built runs from McPherson via Sterling to a point where Medicine Lodge Creek crosses the State line in Barbour County.

THE IRON AND METAL MARKET.

STRUCTURAL IRON.—Prices same as last quoted.

PLATE AND TANK IRON.—Prices are: 2.5@2.6c. for Tank and Boat Plate, 3.5c. for Shell, 4.25@4.5c. for Flange, and 5.5c. for Fire Box.

STEEL RAILS.—They can be had at $39 at the mill.

RAILWAY FASTENINGS.—Spikes are steady at $2.75@$2.85, with a fair demand; Fish Plates, 2.4c., and quiet.

TRACK LAID IN 1882.

Southern States.

	Miles.
VIRGINIA.	
Bright Hope—Chester to Bermuda...10.5 Winterpock to Eppes' Falls..... 3.5	14.00
Chesapeake & Ohio—Newport News s. e. to Mill Creek.....	7.87
Danville & New River (N. G.)—Cascade to Martinsville.....	21.00
Norfolk & Western—New River Div.—New River n. w. to Long Falls, W. Va., 58, of which in Virginia	38.00
Richmond & Mecklenburg—(Br. Richmond & Danville)—Keysville to Chase City..	17.00
Richmond & Allegheny—Henrico Br.—Lorraine to Hungary..... 11.00 In Richmond—extension to dock. 1.75	12.75
Shenandoah Iron Works — Shenandoah Iron Works to Fox Mt.....	6.00
Shenandoah Valley—From 7 m. south of Waynesboro to 8 m. north of Roanoke, completed.....	81.00
Victoria Furnace (N. G.)—Victoria furnace (1½ miles from Goshen) s. e. to Abrams' iron mine.....	10.00
Total.....	207.62
WEST VIRGINIA.	
Kanawha & Coal River—Reported laid...	3.00
Norfolk & Western—New River Div.—Virginia line to Long Falls.....	20.00
Ohio Central—Point Pleasant to Charleston.....	57.00
Paint Creek (N. G.)—From Ches. & Ohio R. R. 21 m. east of Charleston, up Paint Creek	5.00
Weston & Buckhannon (N. G.)—Weston e.....	2.00
West Virginia Central & Pittsburgh—Elk Grove (15 miles from Piedmont) to Abraham's Creek.....	9.00
Winnifred (or Field Creek)—From Ches. & Ohio R. R, 13 m east of Charleston, up Field Creek	6.00
Total.....	102.00
GEORGIA.	
East Tennessee, Virginia & Georgia—Georgia Div.—Rome s. to Macon 161, less 17 m. Geo. Pac. track used.....	144.00
Gainesville & Dahlonega—Gainesville n..	4.00
Gainesville, Jefferson & Southern—Gainesville s. to Horschton.....	24.00
Georgia Pacific—Chattahoochee (8 m. w. of Atlanta) west to Tallapoosa.....	75.50
Marietta & North Georgia (N. G.)—Etowka River to Talking Rock.....	36.00
North-Eastern—Clarksville to Tallulah Falls.....	12.00
Savannah, Florida & Western, Chattahoochee extension—Climax, south	1.08
Total.....	296.58
NORTH CAROLINA.	
Alma & Little Rock—Alma s. w. to Alfordsville.....	12.00
Chester & Lenoir (N. G.)—Lincolnton n. to Maiden.....	8.25
Danville, Mocksville & South-Western (N. G.)—Cascade Junction to Leeksville.	8.00
East Tennessee & Western North Carolina (N. G.)—Tennessee line s. to Cranberry.....	8.00
Midland North Carolina—Goldsboro n. w. to Smithfield.....	22.00
North Carolina Midland—Virginia line s. to Leeksville.....	22.00
Seaboard & Raleigh—Williamston w. to Tarboro.....	33.00
Western North Carolina—Warm Springs to Paint Rock..... 7.00 Ducktown Br.—Asheville to Waynesville..... 29.00	36.00
Wilmington & Weldon, Scotland Neck Br.—Conoconara Swamp to Scotland Neck.....	10.00
Total.....	154.25
SOUTH CAROLINA.	
Augusta & Knoxville—Dorn's mine to Greenwood.....	30.00
Barnwell—Blackville s. to Barnwell.....	9.00
Central of South Carolina—Extended to Sumter.....	18.00
Total.....	57.00
FLORIDA.	
Florida Transit & Peninsular (Florida Tropical)—Ocala s. to Wildwood.....	26.00
Florida Southern (N. G.)—Perry south to Ocala.....	32.00
Jacksonville, St. Augustine & Halifax (N. G.)—From opposite Jacksonville s. e....	6.00
Live Oak & Rowland's Bluff (Br. Sav. Florida & Wn.)—Live Oak s. to New Branford.....	23.60
Pensacola & Atlantic.—Of the total distance between Pensacola and Chattahoochee (160 miles) laid from three points..	180.00
Sanford & Indian River (N. G.)—Jesup Br.—Sanford to Lake Jesup.....	6.00
South Florida—Orlando to Kissimee.....	18.00
St. Johns & Halifax—Rollston east.....	9.00
Savannah, Florida & Western—(Chattahoochee & East Pass Ry.)—Florida line s...	2.88
Total.....	258.48
ALABAMA.	
Cincinnati, Selma & Mobile—Greensboro n. e. to Cincinnati Junct. near Akron...	17.50
Georgia Pacific—Anniston east.....	10.00
Montgomery Southern (N. G.)—Montgomery s. to Bethesda.....	20.00
Total.....	47.50
MISSISSIPPI.	
Natchez, Jackson & Columbus (3 ft. 6 in. gauge)—Myles n. e. to Jackson	36.25
New Orleans & North Eastern (Br. Cin. N. O. & Tex. Pac. R. R.)—Meridian s.....	40.00
West & East—Durant w. to Lexington....	11.00
Total.....	87.25
TENNESSEE.	
Chesapeake, Ohio & Southwestern—Newbern s. to Hatchie 39, Covington n. to Hatchie, 7.....	46.00
East Tennessee, Virginia & Georgia—North Carolina Div. to Paint Rock 7.00 Ohio Div. — Carryville n. w. to Tenn. line..... 12.00 Br. Ooltewah to Red Clay..... 11.50	30.50
East Tennessee & Western North Carolina (N. G.)—Hampton to N. Car. line.....	16.00
Nashville, Chattanooga & St. Louis—Duck River Br. (N. G.)—Petersburg to Fayettsville..... 13.00 (N. G.) Br.—Graham to Centerville 9.00 Jasper Br.—Victoria to Inman.... 5.50	27.50
Tennessee & Sequatchie Valley (N. G.)—Reese's Cut to Jewett.....	10.00
Total.....	130.00
KENTUCKY.	
Louisville & Nashville—Knoxville Br.—Livingston s. to within 5¼ m. of Tenn. line..... 55.00 Br. Madisonville w. to Providence. 16.00	71.00
Owensboro & Nashville—Central City to Ricedale.....	8.00
Total.....	79.00
LOUISIANA.	
Mansfield Branch—From New Orleans Pacific R. R. to Mansfield.....	2.00
Morgan's Louisiana & Texas—Br. Cadiz n. e. to St. Martinsville.....	6.75
Natchez, Red River & Texas (N. G.)—Extended to a point 11 m. west of Vidalia.	2.00
New Orleans Pacific—Completed between Shreveport Jn. and Donaldsville by laying..... 57.00 Br. Shreveport Jn. to Shreveport. 2.00	59.00
New Orleans & Mississippi Valley—New Orleans n.....	10.00
Total.....	79.75

Railway Age.

KNOWLES STEAM PUMP WORKS.—This company is now putting in four of its improved compound condensing duplex pumping engines for the new auxiliary supply of Brooklyn, N. Y., having an aggregate maximum capacity of 16,000,000 gallons per diem, with boilers, etc. Also two of the same for Fremont, O., capacity 5,000,000 gallons; also, two for Freeport, Ill., capacity of 6,000,000 gallons; also two for Council Bluffs, Ia., capacity of 8,000,000 gallons; also for Staten Island, N. Y., of 2,000,000 gallons capacity.