a pouring-hole on its top side. This overlaps the joint on both sides, and would be useful, I think, where it was required to insert a length of pipe between two already in position, as this could be done without the necessity of lifting more than the piece which was to be removed. With regard to the connections and appliances suitable for attachment to cast iron pipes, you will see exhibited a cast iron air-chamber floor, which is an effort to simplify the arrangement now so frequently adopted with advantage of having a manhole, with a floor composed of half pipes as a channel for the passage of the sewage, and a trap beyond it to cut off the drain from the main sewer. In the cast-iron substitute for this appliance, the mouth of the trap is practically extended so as to form a floor for the manhole in itself; and this extension has the advantage of affording a provision for side inlets for the passage of surface water and for other purposes. At the further or house end of the drain, instead of building a shallow manhole, a cast iron terminal is provided which is easily accessible, and which is made secure by means of a brass plug fixed in a ground seating of the same metal. In making a connection between a lead soilpipe and an iron socket, it is well to have a strong copper piece, with brazed lap seam, slipped over the lead and soldered. This allows for an oakum and red-lead joint to be made with sufficient substance to admit of calking. As regards the comparative cost of iron and earthenware for house drains, it must be borne in mind that a great proportion of the total expense of lifting an old drain and laying a new one is common to both systems. For instance, the cost of excavating, filling in, and making good is practically identical. The time occupied in making good the joints of an earthenware drain is as six to one as compared to an iron drain, the number of join's being as three to one in the case of 2 ft. lengths of stoneware, and 6 ft. lengths of iron, and I estimate the time occupied to each as two to one in favor of the metal. This, I estimate, balances the extra cost of the material. The connections, including the air-chamber floor, are more costly than earthenware; but this, in the case of an ordinary London house drain, should not amount to more than £5 in all. I think that the greater security to be obtained from the use of cast iron quite justifies the expenditure of this additional sum. These remarks hold good so long as cast iron is to be obtained at its present price. Other kinds of materials are used for house drains, although bricks are now obsolete. The practical objections to the use of earthenware pipes are—1st. Their liability to twist in fixing. Mr. Ernest Turner speaks of having rejected as much as 60 per cent. of pipes supplied by "well-known manufacturers." 2d. Their liability to fracture. Concussion without fracture of the surface is often sufficient to detach a branch piece from a pipe in which the material seems to be continuous, although the connection is often secured by little or nothing but the glazing. As such a contingency may delay a squad of workmen for several hours, until another pipe and branch has been obtained, there is a temptation to make use of defective pipes. Experience shows that workmen are not above yielding to the temptation of concealment. Broken bends and bad connections are frequently found in places which are most available for the passage of sewer gas into a dwelling. 3d. The short lengths in which earthenware pipes are made necessitate an excessive number of joints, in order to make up the length of an ordinary house drain. The joints, when made with clay, are inefficient; and when made with cement, are subject to many drawbacks which nothing but great and uncommon pains on the part of the workman can overcome. The projection of cement to the interior of the joint is a necessary condition, and this must be removed. In doing so, the pipe is liable to movement during the critical period when the cement is setting. The position of a pipe at the bottom of a deep cutting renders it difficult to pack the joint from the bottom. Only a small proportion of earthenware house drains are found to be tight when tested with a pressure of even a few inches head of water. These are among the considerations which have led me to adopt iron in preference to other materials, and I shall be glad if this paper has the effect of calling further attention to the subject.

THE POWER OF WATER.

The properties of water are only partially understood by those who have never seen it under high pressure. The Virginia City Water Company gets its supply from Marlette Lake, on the Tahoe side of the mountain. It gets it through by a long tunnel, is then on the crest of a high mountain opposite Mount Davidson, with Washoe Valley between. To cross this valley by a flume would be almost impossible, so the water is carried down the mountain side to the bottom, and crosses under the V. & T. Railroad track, on the divide between Washoe and Eagle valleys, then up again to the required height in iron pipes. The depression created in the line of carriage is 1,720 feet, and the pressure on the pipes is 800 pounds to the square inch. One pipe is eleven inches in diameter, and is quarter-inch iron, lap-welded, and eighteen feet long, with screw joints. There is little trouble from it; but the other, which is twelve inches in diameter and is riveted pipe, makes more or less trouble all the time. The pipe is laid with the seam down, and whenever a crack is made by the frost or sun warping it, or from any other other cause, the stream pours forth with tremendous force. If the joint is broken open, of course the whole stream is loose and goes tearing down the mountain, but usually the escape is very small. The break last week was less than five-eighths of an inch in diameter, and yet the water in the flume was lowered an inch and a half by it, and the pressure went down fifteen or twenty pounds. Capt. Overton says that fifty inches of water went through it. It has been probably a year in cutting out, and was made by a little stream hardly visible to the naked eye that escaped through a joint and struck the pipe two or three feet off, cutting away the iron until the pressure inside broke it through. When such a break occurs the noise can be heard for half a mile, and the earth shakes for hundreds of feet around. A break the size of a knitting needle will cut a hole in the pipe in half an hour. Such breaks are repaired by pulling a band around the pipe, pouring in molten lead, and tamping it in. Such a stream bores through a rock like a sand blast. The flying water is as hard as iron, and feels rough like a file to the touch. It is impossible to turn it with the hand, as it tears the flesh off the bones, and if the fingers are stuck into the stream, with the point up, the nails are instantly turned black and sometimes torn from the flesh.—*Reno Gazette.*

THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.

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

(*Continued from page* 364.)

DLI.—CORNELL UNIVERSITY.

Cornell University, at Ithaca, New York, in lat. 42° 26′ 57″ N., long. 76° 30′ W., is on Fall Creek, near the south end of Cayuga Lake.

The University was opened in 1868, with an endowment of $500,000 from the Hon. Ezra Cornell, and under a charter granted by the State securing to it the income from a grant of 990,000 acres of public lands from the United States government.

Water-works were built by the university in 1875 after the plans and under the superintendence of Prof. E. A. Fuertes, C. E., taking the supply from Fall Creek, which has a water-shed of 30 square miles. The stream is dammed directly above the "Trip Hammer Fall," by a stone masonry dam 15 ft. high, abutting on rock at each end. The wall is vertical on the lower face and battered on the upper. When turbid, the water is filtered through a large wooden box filled with stone-gravel and sand, which is placed in the reservoir near the gate-chamber. The water is pumped to a height of 145 ft. by a Worthington water engine, working under a head of 25 ft., and capable of delivering 72,000 gallons per day through a 4-in. pipe into the reservoir, which is in excavation and embankment, and is 144 by 100 ft. and 21 ft. deep, with the inner slopes covered with 2 ft. of clay puddle, on which is laid a 10-in. stone facing grouted with Fayetteville ordinary water lime.

Distribution is by cast-iron pipe of from 6 to 3 in. diameter, The length of pipe laid is not known. There are 15 fire hydrants, 12 gates and about 30 taps. Service pipes are of lead for domestic use, and of wrought iron for the miscellaneous purposes to which the water is applied around the University. There are 12 professors' houses supplied and 14 University buildings. The daily consumption is 70,000 gallons. Another water engine is in course of erection, of about 150,000 gallons daily capacity.

The works cost $17,000. The cost of operation is not known. The works are in charge of Prof. J. L. Morris, the Superintendent of buildings.

During the construction of the works, delay in the delivery of the pipes, made it necessary to lay in freezing weather a 12 in. and 6 in. pipe through a trench left open in a made embankment at the reservoir. The pipe was laid on a concrete foundation of irregular width, and then covered with bands or rings of concrete, one foot wide and thick and one foot apart. This was then covered with clay, compacted. It has not leaked. The reservoir bank, which was completed in freezing weather, leaked on being first filled, before the walls were grouted. Since the wall was grouted the reservoir has not leaked.

DLII.—KINGSTON, MASS.

Kingston, Massachusetts, in lat. 42° N., long. 70° 40′ W., is on irregular ground. It was settled about 1630.

Water-works were built by a private company in 1804, taking the supply from Cuff's Spring, after plans of Barstow Cook. The spring issues from the side of a high hill, and the water is lifted 100 ft. by a pump of 3½ in. bore and 11 in. stroke, driven by water power, pumping directly into the mains.

Distribution is by 2 miles of pipe of 1¾ in. diameter. The first pipe was of wood. Iron was afterward substituted, and this has been replaced by lead pipe. Fifty families are supplied. There are no fire hydrants. The daily consumption is 3,800 gallons. The population of the town in 1880 was 1,524. The capital stock of the company is $2,500. The annual expenses are $100, and the receipts about $300. Grace Evins is the President, and Henry Hunt, Treasurer.

THE PALESTINE CANAL.

No. 4 STOREY'S GATE, GREAT GEORGE STREET,
WESTMINSTER, S. W., July 17, 1883.

SIR: I have considered the papers submitted to me with reference to making a through water-way communication between the Mediterranean and the Red Sea for ships of the largest class along the depressed gorge of the River Jordan and the Dead Sea by means of two communicating canals, one commencing in the Bay of Acre, to connect the Mediterranean with the northern end of the valley of the Jordan, and the other along the Waddy Arabah, to connect its southern end with the Red Sea.

The northern canal between the Bay of Acre and the northern end of the valley of the Jordan would be constructed across the plain of Esdraelon, and would be about 25 miles in length and, assuming the summit of the watershed between the Bay of Acre and the Jordan Valley to be, as therein stated, only 108 feet about the level of the Mediterranean Sea, and that the excavation for the canal would have to be made principally through chalk and laterite, there would appear to be no engineering difficulties to be overcome other than those necessarily involved in the magnitude of the operations.

The crucial point, however, with reference to the project is that which relates to filling the immense depression in the valley of the Jordan with water up to the sea-level by means of a channel to be formed from the northern end of the Gulf of Akabah, along the Waddy-Arabah to the southern end of the Jordan Valley depression.

To fill this depression with water and to convert it into an inland sea of the same level as the Mediterranean and the Red seas, in a period, say, of three years from the completion of the requisite channel, and to make at the same time due provision for evaporation, this southern channel would have to be large enough to convey over 1,000,000 cu. yds. of water along it per minute during that period.

To pass this quantity of water it is estimated that, with a fall at the rate of 6 ft. per mile, this channel would have to be 480 yds. wide and 20 ft. deep, and it is assumed that a channel of this description may be cut through the loose sand which is said to compose the southern end of the Waddy-Arabah, by means of the properly-directed scour of an elementary channel, having a bottom width of 50 ft. and carrying a solid body of water 10 ft. in depth to begin with.

I do not know what data exist for the assumption that the sub-soil of the Waddy-Arabah consists of loose sand to any great depth, and I believe that, up to the present time, no levels have been taken along it of any reliable character for determining the height or position of the water-shed line between the Red Sea and the valley of the Jordan; but, looking at the great interests involved and at the immense importance of obtaining, if possible, a water-way to India independent of the Suez Canal and all its untoward complications, I should advise you to assist the syndicate which has these preliminary questions under investigation as far as lays in your power.

It is impossible to say without further data whether the scheme is actually feasible or not; but should the difficulties be much greater than those anticipated by its promoters, the project is one which, if practicable at any reasonable cost, promises such undoubted financial and commercial advantages that I think it should not be allowed to drop until, after the most searching investigation, it is proved to be impossible. I am, sir, your obedient servant.

HENRY J. MARTIN, M. Inst. C. E.

To Mr. John Corbett, Member of Parliament.
—*London Times.*

THE TEHUANTEPEC SHIP RAILWAY.—The line has been located from Minatitlan to Kilometer 80, on the other bank of the Goatzacoatcos River. The surveys were made by engineers Hendrickson and Hall; these gentlemen have, however, been compelled to resign from ill health. Messrs. Van Brocklin and Thayer finished the preliminary surveys between Tepechillo and Tarifa. Messrs. Thayer and Quien have begun the survey between Tarifa and Salina Cruz. Mr. Corthell of New York, is to draw up the definite plans. Engineer Orr has cleared 33,000 square meters of surface. There is a great scarcity of labor on the Tehuantepec Railway.