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T. G. Parthasarathy

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India Office,
London, 27th October 1881.

Statistics and Commerce
No. 25

To His Excellency
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Honourable The Governor in
Fort St. George.

a. 1. I have given instructions for the
on, through the Stores Department, of 70
the accompanying Report, by Captain
the drainage of Memphis, in the United
America.

quest that your Excellency will cause the
measures to be taken for the circulation
ies of this Report to the best advantage.

I have the honour to be,

Sir,

Your most obedient humble Servant,

(Signed) HARTINGTON.

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Drainage of Memphis (Tennessee), in the United States of America.

In consequence of the numerous cases mentioned in the Sanitary Reports for India in which it appeared that economical systems for drainage are urgently required in that country, I was led, whilst in the United States last autumn, to investigate the arrangements which have been adopted at Memphis (Tennessee), where the conditions of the town appeared to present some similarity to those of many Indian towns, viz., the absence of sanitary precautions in the face of a high temperature, and a long period of dry weather, during the summer months; combined with a low financial condition of the municipality.

This latter consideration rendered it imperative that the arrangements which were adopted at Memphis should be largely controlled by considerations of economy. So far as the present limited experience goes, the economical methods adopted have proved efficient.

The main object of furnishing an account of these works is to afford useful matter for the consideration of engineers engaged in Indian sewerage works, and not with any view of suggesting that the system adopted in Memphis should be blindly followed.

The city of Memphis is situated in latitude $35^{\circ} 9' N.$, longitude $90^{\circ} W.$ It stands on the eastern side of the Mississippi river, to the south of its junction with Wolf river. The older part of the town stands next the river, upon a bluff or ridge bounded by a stream called Bayou Gayoso, tributary to Wolf river. The remainder of the town, behind this bluff, is on lower ground, intersected by several streams, which have their origin in springs of pure good water in the country, and which flow into the main bayou above mentioned; and thus the ground on which the town stands is favourably situated as regards surface drainage.

During the short period (little over half a century) of her existence, the city of Memphis has been the theatre of no less than twenty-two epidemic visitations of disease,—small-pox, cholera, yellow fever, dengue, erysipelas, puerperal fever. Her annual death-rate, even during non-epidemic years, has rarely fallen below 3.5 per cent., 35 in the 1,000—something more than double the attainable standard of modern cities.

The town had been subjected to visitations of yellow fever in 1867 and 1873. At the beginning of 1878 the city was bankrupt. Its taxable wealth available for the support of the State, county, and city government, which before the Civil War was estimated at \$28,000,000, had been reduced to about \$12,000,000. The population had meanwhile doubled.

Memphis, who, under the system of slavery which prevailed up to the breaking out of the Civil War, had been productive labourers in the cotton fields of the adjoining States, attracted by the excitement it afforded, flocked to the city, where at least one third of them were added to the ranks of the very poor, and either as petty thieves or worthless paupers depredated partly upon the industrious few of their own colour, but for the most part upon the thrifty whites. Thus the non-producers, those who consume without labouring, and live without the least regard for the obligations of good citizenship, were increased to the proportions of a small army. The debt amounted to \$5,500,000. The summer of 1878 was intensely hot.

A case of yellow fever was reported to have occurred at New Orleans on the 13th of July 1878. At the beginning of August there were indications, in New Orleans, that the epidemic was likely to be of a very aggravated form. The population of Memphis became seriously alarmed, and quarantine was established round Memphis in the beginning of August.

On the 9th August yellow fever was reported to have broken out at Grenada (Miss.). The first case of yellow fever occurred at Memphis on the 14th August. There were 22 cases on the 15th and 33 on the 16th. The population of Memphis at that time was between 40,000 and 50,000 inhabitants. More than one half of this population then took alarm and left the town.

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The medical estimate puts the total population which remained during the epidemic at 19,600 and the total sick at 17,600. Deaths were 5,150, a little less than one third of the whole population. Members of the "Howard Visiting Corps," who have resided in the city many years and know it well, and whose business during the epidemic it was to visit every ward every day that at no time were there more than 20,000 persons in the city, if so, and that, of these, fully 14,000 were Negroes, leaving only 6,000 white people. Of the 14,000 Negroes, 916 died of the fever, and of the 6,000 whites 4,204 died, or 70 per cent. of the whole number of the whites. Not more than 200 white people escaped the fever, and most of these had suffered from yellow fever in previous epidemics.

The sanitary condition of the city was successful in the extreme. There were no public sewers, and the refuse and filth were carried into cesspools and private vaults, while not a small portion found its way into the gutters of the public streets, and these during a prolonged dry season became stinking and putrescent, and emitted the foulest odours.

Some years ago many of the streets were paved with wood pavement; this had very much decayed, and readily absorbed some of the liquid filth that flowed over the rotten wooden gutters, and in course of time the streets became so permeated with it that the periodical flushings of rain were utterly failed to cleanse them. The street surfaces were then the constant source of poisonous exhalations, which none of the inhabitants in the city limits could avoid, as the subsoil was reeking with the offal and excreta of the community.

There was no organized scavenger system, nor any means by which the ashes and garbage could be daily carted away. The great accumulations of forty years were decaying upon the surface. The Bayou Flats, dividing the city, and which was the receptacle of the contents of privies and water-closets, was sluggish and without sufficient current, owing to a want of water, and to the fact that there had been scarcely any rain for several weeks. The carcasses of dead animals were decaying in many parts of the city, and pools which had formed at the abutments of the several bridges were stagnant and covered with a scum of filth, emitting a deadly effluvia. The cellars of the houses in the leading thoroughfares were also alembics, in which were manufactured noxious gases which stole out and made the night air an almost killing poison.

The privy pits in Memphis are so deep as to reach the sand substratum on which rests the great clay bank known as the Old River Bluffs.

Through this sand the water of the Mississippi finds its way at every great rise, so that in many places the gradual advance of the Mississippi may be actually gauged by the rise of the excreta, which, when the rains fall, are drawn after the water through the soil.

In the early days of Memphis, privy pits or pits were purposely, and are yet, made deep enough to reach this sand, as a means of dispensing with the labour of the night-soiler.

There is an old city ordinance still in force which was very defective. For instance, it says, whenever a privy vault is filled within three feet of the surface it must be emptied. The result in many instances was, that only enough was taken out to evade the law, although many of the vaults were from 50 to 60 feet deep.

Another plan has been resorted to, called "money-combing"; that is, a new pit is dug by the old one, so close that they nearly touch one. Owing to such a disregard of cleanliness there were privy pits and vaults in Memphis, in which had accumulated excreta, and even kitchen offal, for from 10 to 20 years.

A general idea of the condition of the city may be gathered from the description of a detailed examination of one of the blocks of buildings made by the National Board of Health.

"This block contains 202 houses, the average age of which was about 20 years. There were 65 cellars. In 37 of these there was little or no provision for ventilation. 54 of the cellars were damp or wet; the walls in some cases soaked with leakage from privy vaults; in other cases stagnant water 6 inches deep, was standing on the floors; in some cases disused cisterns contained foul water. There were 184 privies, of which 32 are in cellars, 48 in the other parts of the houses with vaults beneath; 48 adjoin houses, and the remainder are in the yards, at distances of from 3 to 40 feet from living rooms; 23 houses are without privies, the occupants using a neighbouring one. Of the total number less than 40 are in good sanitary condition. The prevailing evils were deep vaults, full or nearly so, and leaky and broken vaults, allowing the

contents to soak into the ground; dilapidated sheds, rotten floors and seats, old hogs-heads sunk into the ground for vaults, &c.

"Of the yards, 80 were filthy and undrained, containing more or less decomposing organic matter, soaked with stable and other ooze and faecal matter. 48 of the yards were fairly good, being brick, paved and drained with brick gutters. The drainage was entirely surface. 64 houses had brick drains, of which 24 were in good condition, and 40 foul, broken, and choked up where they run under the houses from the rear to the street gutters in front. The drainage of the remaining 138 lots was either by dirt gullies or left to the natural slope of the ground."

The water-supply of the town was not satisfactory. It was partly derived from cisterns in the houses, partly from a large rain-water reservoir, and partly pumped from Wolf river, and delivered by pipes through hydrants. The cisterns were for the most part built in cellars, and as a rule within from 8 to 20 feet of the privy vaults. It was estimated that eight out of ten were pervious to water. The soil is of a porous character and seepage is constantly going on, especially in wet weather. Owing to this seepage the vaults and cisterns are brought in communication. So unmistakably is this the case in many cisterns, that the rise or fall in the cistern from seepage equals that in the privy vault.

Owing to the great depth of these privy vaults and the mild winters, the temperature never falls low enough to destroy animal life (animalculæ). In summer the temperature cannot be high enough in these vaults to create very rapid changes.

An examination of the water-supply was made in 1879 by the National Board of Health. There were 59 waters examined, of which 36 were from sunk cisterns, one from the round tank or reservoir, five from wells, one from Elmwood Creek, six from Wolf river, and one from Mississippi river.

Of the 36 cisterns, 10 were in sound condition, and 26 leaked. The waters they contained may be classified as follows:—

	Good.	Fair.	Bad from foulness of Cistern.	Bad from infiltration of Sewage.
Ten sound cisterns	7	3	—	—
Twenty-six leaky cisterns	11	3	2	10
	18	6	2	10

These 36 were believed to be above the average of Memphis cisterns, as nine of them belonged to the public schools, while not more than a dozen of the samples were sent in by inspectors, the others having been furnished from the residences of gentlemen who attach importance to the water-supply of their households, and endeavour to keep their cisterns in good condition.

The sample from the tank or rain-water reservoir was good.

Of the wells four were organically pure and one exceedingly impure, the last showing that a leak in the brick lining of the well may admit of sewage infiltration as readily as one in the brick wall of a cistern. In some of the pure wells the amount of earthy and saline matters was such as to cause a doubt as to their wholesomeness. Of the running waters that from the creek at Elmwood Cemetery was very impure. A sample from the mouth of Wolf river, taken after recent rains, was exceedingly impure. A sample from the same river furnished by the city supply before rain was also exceedingly impure. Three samples from Wolf river, as stored in cisterns when the river was low and free from turbidity, were of good quality. One sample from the river at a period of normal flow, when passed through a charcoal filter proved exceedingly pure. One sample of Mississippi river water, taken after the rains from a point half a mile above the mouth of Wolf river, proved a fair water, being but slightly inferior to that delivered in Washington as the city supply.

After the cessation of the fever in 1878 the city underwent considerable purification. The streets were cleansed, the houses ventilated and exposed to the cold of the winter, and artificial means of disinfection were applied.

To outside appearance the city thus cleansed would have compared favourably with other cities north and south of it which were free from fever; but the privy-pits and vaults, the impure sewers and polluted subsoil, and water-supply remained.

In the summer of 1879 there was a fresh outbreak of yellow fever. The first case

was reported on the 9th of July. The disease did not become epidemic till about the 10th August.

The estimated population of Memphis at the commencement of this epidemic of 1879 according to the reports of Col. J. H. Cameron, Superintendent of Camps, was 38,400. The greater part of this population, viz., 24,800 persons, were then moved out into camps, situated within 5 to 10 miles of the city, and the population of the city itself was thus reduced to 13,600, of which about two thirds were blacks. Prompt and active depopulation appears to have prevented a repetition of an epidemic like that of 1878.

The following are the cases reported and the deaths:—

	White.	Coloured.	Total.
Cases - - - -	853	679	1,532
Deaths - - - -	379	106	485

During this epidemic the "National Board of Health" made a survey and report upon Memphis.

The following are the chief recommendations they made:—

1. The systematic opening up and chilling throughout the winter of every house within the city limits, the thorough exposure to sun and air of all textile fabrics, bedding, clothing, carpets, upholstered furniture, &c., the destruction by fire of every article suspected of being infected by exposure to yellow fever during either 1878 or 1879, and of all accumulations of rags, paper stock, and second-hand clothing, the usual contents of junk shops and second-hand stores.

2. The absolute destruction of about 50 specified houses and groups of buildings as unfit for occupancy, and infected beyond the possibility of renovation; the vacation of a still larger number, pending alterations necessary to fit them for healthful occupation; and the passage of an ordinance forbidding the future erection of buildings unprovided with proper means of subventilation and other sanitary requirements.

3. A radical change in the water-supply involving the total abandonment of all existing wells, and many of the underground cisterns, and the substitution of Mississippi river water for the water of Wolf river, now supplied by the water-works.

4. An equally radical change in the disposal of excremental and other refuse, and domestic and manufacturing wastes, this to be begun at once by emptying, disinfecting, and filling with dry clean earth all existing privy vaults, and substituting therefore some cheap and convenient form of dry-earth closet.

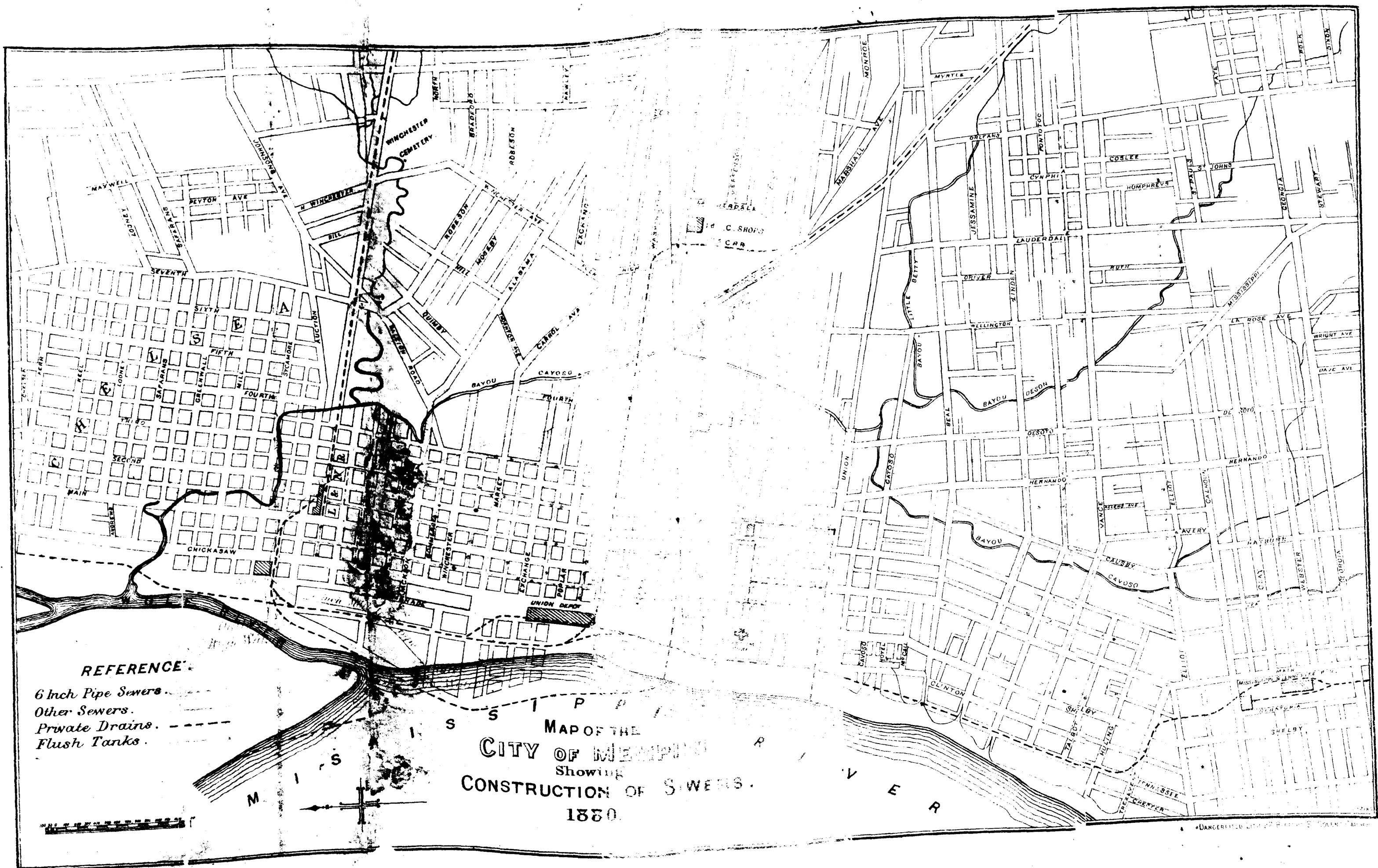
5. The complete sewerage and subsoil drainage of the town.

6. The reclamation of Bayou Gayoso and its tributaries by the acquisition of the ground on either side for a sufficient space to prevent fouling of the contained waters, and the erection of a dam, with suitable valves and a steam pump, to keep the Mississippi river from flowing up into the town in high water, which at present is a potent source of soil saturation.

As regards the streets, the Board remarked that with the exception of those devoted to heavy traffic, it was advisable that all streets should be constructed of Paducah gravel, laid on a properly shaped road bed, after subsoil drains had been established, and that the gutters and curbs should be made of concrete. And they added that few places possessed greater natural advantages than the city of Memphis for drainage, removal of excrement, garbage, &c., to secure that healthfulness so necessary to commercial prosperity; and that by carrying out the above recommendations and by availing itself fully of what was then known as the causes of disease in excess, and the methods of avoiding or destroying these causes, Memphis might soon become one of the healthiest cities in the valley of the Mississippi.

The municipal authorities set to work immediately after the epidemic of 1879, to remove the sources of impurity pointed out by the National Board of Health.

They obtained plans for the drainage of the town, but those drawn up upon the



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ordinary systems of town sewerage were estimated to cost from 300,000Z. to 600,000Z. In the bankrupt condition in which this found itself, expense was a material consideration. Under these circumstances, Colonel Waring, of Newport (Rhode Island), the well known sanitary engineer, proposed that, under the special circumstances of the configuration of the town of Memphis, the sewers should be constructed for sewage water alone, rigidly excluding surface and subsoil drainage, the amount of water necessary to furnish conveyance for such solid matter as enters the sewers being introduced from another source.

The system he proposed was estimated to cost about 50,000Z. only.

This estimate included not only the cost of a sewerage system, but also other sanitary work; the laying of about 40 miles of subsoil drainage, and also the reclamation of the bayou by shutting out the high water of the Mississippi by means of a dam with proper valves, and a steam pump to pump out the bayou during the period when the level of the river was high.

The accompanying plan shows the general arrangement of the sewers. (See map.)

The new system has an outlet through a large iron pipe draining the county jail, which delivers into Wolf river. This outlet is to be used permanently only during high stages of the river, when the back water in the long permanent main would cause a liability to deposit. The permanent main discharges below low water

into the Mississippi river, at the foot of Winchester Street, south of the mouth of Wolf river. Its lower end is of cast-iron pipe, with lead joints, and so much of it as is made in high and dry ground is of brick. Its diameter is 20 inches. The flow can be turned at pleasure into the jail sewer or into the permanent main by a swinging section of pipe or switch working in a brick chamber. (See sketch, Fig. 1.) The 20-inch brick main continues as far up as Jackson Street; here it is forked to receive a 12-inch vitrified pipe main running along the east side of the bayou, and a 15-inch vitrified pipe main west of the bayou.

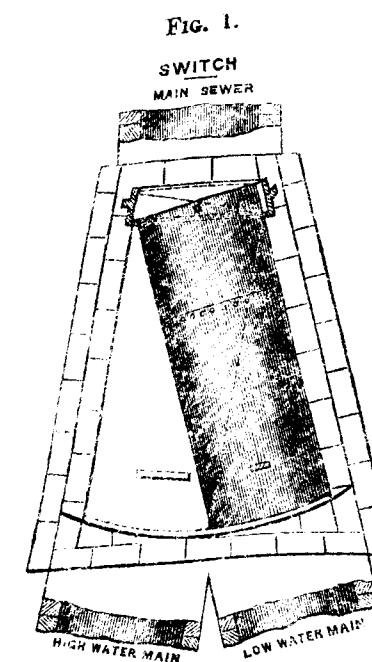
The extension of these mains beyond Gayoso Street and a few sub-main branches are of smaller pipe. There are man-holes along these main lines, by which their working may be inspected. These two mains (12-inch and 15-inch) constitute the outlet channels for the whole area of the city, the lateral sewers entering on courses oblique to the direction of the flow, so that the discharge of each lateral, having considerable velocity from its rapid descent, will increase rather than retard the velocity of the current in the main, which it was necessary to lay with a

comparatively slight fall, that of the 15-inch pipe being only 2 inches in 100 feet. The lateral sewers are almost invariably 6 inches in diameter. In rare cases, where they serve as the outlets for more than three thousand feet in length, they are increased to 8 inches.

So far as the conformation of the ground and the division of property would admit, they have been laid in the alleys and not in the streets, thus affording direct communication with the backs of houses, and avoiding the necessity for carrying house drains under the buildings, the plumbing appliances of houses at Memphis being almost universally at the rear. In some cases the lots do not run through to the alley, and to accommodate houses so situated subordinate sewers have been laid in the streets, these being, where only one or two houses are to be accommodated, only 4 inches in diameter.

The sewers were laid on an average about 6½ feet below the surface; as but few buildings had cellars, this depth was amply sufficient. In some cases, as at street crossings, where the sewer came so near the surface as to endanger the crushing in of the vitrified pipe sewer at times when the ground is very soft, a few lengths of iron pipe were used.

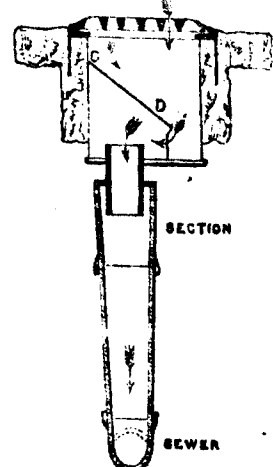
At every point along each line where it is at all likely that at any future time a house may be built, an oblique junction piece is built in with the sewer, its mouth being temporarily closed. Wherever a house is now standing, in order to protect the sewer from injury at the hands of careless workmen, to avoid the necessity for digging up the street, and to make the connection as costly to the householder, a four-inch



branch is carried up to the lot line and is placed at three feet below the surface of the ground, which in that climate is a sufficient depth to protect house drains, as there is little frost. By this arrangement the plumber, in making his connection, finds the public sewer connection at the limit of his own property. It has been the custom heretofore to make the connection between the house drain and the sewer by a branch piece of the same diameter as the house drain, entering the sewer above its bottom and below its top. The house connection branches used in Memphis are funnel shaped, the top and bottom lines being tangent to the circumference of the sewer, so that the house drainage is delivered at the very bottom of the flow of the sewer, with a tendency to increase its velocity, while the ventilation of the sewer reaches its very top.

The lateral sewers have no man-holes, or air-holes, or communication of any sort with the surface of the street, except at one point near the lower end of each, where there is a fresh air inlet, which may also serve for the inspection of the working of the sewer. This fresh air inlet has a communication with the surface of the ground through a large and very open grating, beneath which a grating plate of iron is placed to prevent dirt from falling into the sewer, this plate leads it into a receptacle at the side, from

FIG. 2.



the sewer, and pipe shall be made a receptacle at the top, which it may be easily removed (see sketch, Fig. 2). This sloping plate or cover may be lifted to a vertical position to give a clear view of the sewer below. Aside from the fresh air inlets indicated, only a current for ventilation, it is a fundamental principle of the ordinance regulating house connections that every connection, of whatever character, shall be continued without intervening trap, by a pipe fully four inches in diameter, and above the top of the traps so connected. And such connection is compulsory, and as it is made a misdemeanor to have at least one water-closet for every occupied house, when the work is completed there will be not less than 100 of these four-inch ventilating pipes for the 40 miles of sewer in the city, being an average of one ventilator for every 400 feet of sewer.



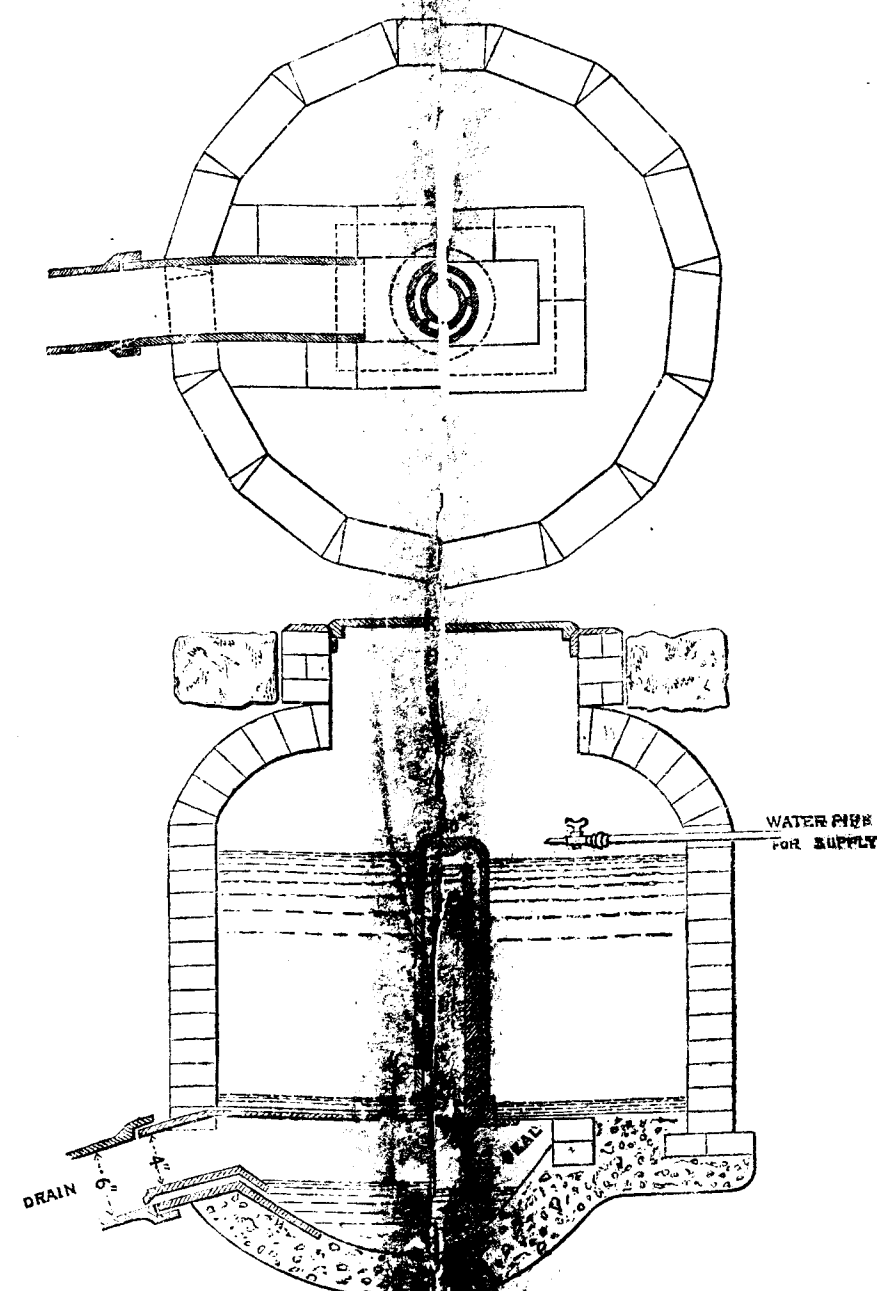
SEWER

ventilator for sewer

At the head of each sewer there is a tank, having a capacity of about 112 gallons. This tank is built of masonry above the level of the head of the sewer from the public water-supply, barely furnished with Field's automatic siphon flow, is sure to be brought into operation; the whole amount of water in the pipe; the whole amount of water in the pipe (40 seconds), and rushes down the sewer substance of whatever character, the flushing stream, according to the more than half full 900 feet from the fall of the sewer. At a fall of 100 feet point where the natural flow is able to end of its own sewer to flush.

It is thus immaterial whether all the sewage is flushed off at once or irregularly. This flush tank is one of the essential features of the combination; indeed without it the use of any sewers not receiving the sewage would be extremely unsafe. Aside from this means of action, the sewage would accumulate to a dangerous extent in the tanks and obstructions before they can be removed. The flush tank has the further very

important effect of carrying forward to an outlet, at least once in 24 hours, all organic matter which, if allowed to remain a longer time, would enter into a dangerous



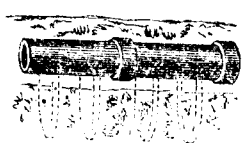
decomposition, for even in a 6-inch sewer there is a tendency to deposit faecal matter and other solid substances toward the head ends of the sewers where the regular flow has not yet accumulated sufficient velocity to sweep them forward. In the Memphis works such deposits are rendered impossible by the production of sewer-gas as a consequence is substantially prevented.

Some of the details of the construction of these sewers are different from those in common use. Ordinarily pipe sewers are laid on the lower end of the drain upward, so that water accumulating in the trench is carried off by the sewers as they are laid. But it is impossible to make a tight joint when the pipe is required to carry water before the cement hardens. Therefore with the small diameter here used, absolute cleanliness is very important. Therefore the laying of each line was begun at its upper end, every effort being made to exclude soil-water absolutely. This was effected by a system of subsoil drainage carried on in connection with the sewerage. Agricultural tiles, varying from 14 to 24 inches diameter, were laid in the trenches by the side of the sewers. The joints were covered with paper, to prevent the loose filling from stopping the joint. In very wet soil it was necessary to lay these tiles in advance of the sewers by digging a narrow trench below the grade of the sewer. Into this trench the tiles were laid and covered with boards to prevent their being disturbed while laying the pipes. These subsoil drains were provided with an outlet into the bayou.

Although the natural soil of Memphis is generally very good and firm, in many places in grading the streets and alleys the bayous and depressions have been filled. In such places the bottom is as bad as possible. In several instances the lower part of the trench was actually dug with buckets and in one case the man laying the pipes sank in the slush until his knee was down to the level of the flow line of the pipe. The method devised to get over the difficulty was to support each pipe on two piles, termed "saddle piles," made of boards eight inches wide, sharpened at the lower end, and long enough to drive into firm ground. These saddle piles are cut out at the top to a half circle, fitting the outside of the pipe. (See sketch, Fig. 4.)

FIG. 4.

SADDLE PILES



These piles were driven firmly until the bottom of the half circle was exactly at the proper grade, and the pipes were supported upon them. Where the amount of water was so great as to interfere with the setting of the cement, the trench was dug out considerably below the grade line, the joints standing high and dry until firmly set. After the sewer was finished and the subsoil drain laid underneath the main sewer and extended to its outlet in the bayou, all the wet places referred to became speedily dry.

It is a frequent objection to pipe-sewers that slight projections of cement at the joints act, by catching lint, rags, &c., as a nucleus for an obstruction. To prevent such asperities the joints of these sewers have been laid, in all cases, with gaskin, a small rope of oakum being crowded in between the collar before the cement is put on. It is found in practice that the collars on the vitrified pipes are generally so large and so irregular that the bore of the pipe does not make a continuous concentric tube, the spigot end of the pipe usually dropping out of line, making at each joint a hump which interferes with the continuity of the fall and with the smoothness of the flow. To remedy this difficulty there was used an "adjustor," to be inserted in the pipe, having three india-rubber bearings, the turning of a screw these bearings pressing against the inner circumference of the pipe, and they hold the pipe absolutely concentric until the gaskin is wedged in place, this joint being cemented by its gaskin, so that any jarring in the cement of the third joint shall be taken up by the gaskin of the second without disturbing the cement of the first. This arrangement has been found in practice to work perfectly well and to secure an absolutely concentric conduit.

Great care was necessary in maintaining the grade while laying the pipes. On account of the very small natural inclination of the bayou but very slight grades were attainable; for nearly half the length of the west side main the grade is one foot in six hundred, above that it is one foot in three hundred, and still further up one foot in three hundred. In order to lay the pipes in the bottom of the trenches at stationing to the flow line. The pipe layer was furnished with a straight edge of sufficient length to reach from stake to stake; this straight edge was just so much wider at the lower end as would represent the fall for the length of the pipe it was desired to test. On the other end on the nearest stake below the pipe; then a spirit level was placed on the straight edge, and if not found to be level, the pipe was raised or lowered until it came so.

It is believed that the whole system of pipes is laid absolutely true to grade; that the pipes are absolutely concentric, and that the continuity of the whole system is mathematically exact. An examination of a certain piece of very bad ground, made by opening the trench, showed that the work perfectly, and that the tile drains had been laid under the ground completely under the drain. Every joint was firm and without leakage, and the work completely satisfactory. The outlet of the tile drain showed a small stream running continuously.

So far as the healthfulness of Memphis is concerned, the natural wetness of much of the soil, and the springy condition of the soil from the filling in of old bayous and swamps, was very detrimental. The drainage of the soil was, therefore, thought to be as important as the building of sewers.

It has been mentioned that this soil has been accomplished by the use of agricultural drain tiles, delivering, not only the main sewer, but beyond it into the bayou. But as the sewers are between four and four hundred feet apart—too far for a complete draining of the subsoil—on each side of the edge of the side walk at each side of the bayou. From the experience gained to the present time the result is satisfactory.

The cost of the drainage and sewerage, including labour, material, engineering, and incidentals, has been about \$137,000, or about 28,000¢. The average cost per foot of the 6-inch sewers for pipes, house connection branches, ditching, laying, and back filling, not including engineering and inspection, is estimated at 60 cents.

In addition to these works, the improvement of Bayou Gayoso is being proceeded with.

Bayou Gayoso is a deep winding gully through the heart of the city, and serves as the outlet for a watershed of about five thousand acres. In many parts its shores were lined with privies, whose contents flowed down its sides, and it was a convenient receptacle for all manner of filth from the houses along its course. It also received a number of drains, bringing water-closet and other refuse from houses sometimes at a considerable distance from it. All these things rendered it a foul open sewer, of a most objectionable character. These evils have been removed by the sewerage works.

But, in addition to this, it served as a channel for the penetration of the flood waters of the Mississippi quite up to the heart of the town. This flood water had no perceptible flow, and it stood at such a height as to lead to the complete saturation or overflowing of wide areas of occupied ground. Many houses near it are built on piles, and during the months of high water nearly every year they were entirely underlaid by a greater or less depth of foul, stagnant, scum-covered water. The district so affected was notoriously the worst, in its sanitary condition, of the whole city.

The improvement consists of a dam for excluding the flood water of the river, a low valved outlet for the removal of the natural stream during low stages of the river, a steam pump to discharge the natural stream during high stages, and large flood-gates to discharge the water of heavy storms at all seasons. The pump to be used is a most simple and ingenious device for forcing water forward against a head, while allowing a free natural flow at ordinary stages of the river. This pump (the invention of Mr. Eijnje Van Salverda) has been largely used in Holland for more than thirty years.

This account of the sewerage will suffice to explain generally the system which has been adopted; it is too recent to enable a decided opinion to be expressed upon its permanent success, but so far as experience goes it has proved effectual. It presents several novel features which require to be tested by further experience before they could be recommended for general adoption. For instance, it may be questioned whether the mode of supporting the pipes on collar piles in crossing deposits of silt or soft ground will permanently secure a sufficiently durable foundation for retaining the pipes at a true grade; it is alleged that, when the soil under the pipes so laid has been examined after a few months, it has been found to be perfectly sound, but until further experience has been acquired by the lapse of time, it remains a question whether a better foundation and the use of iron pipes would not have been preferable in these positions. It may also be observed that it would have been desirable that the main sewers should have been true in line and in gradient, with man-holes provided with moveable and ventilating covers at each change of direction, and for the main sewer to have been amply ventilated according to the most recent English practice. The ample flushing arrangements for the small drains seem to be worthy of approval, and there would be little ground for objection to the direct communication which exists between the house drains and the sewers, by which the house drains become ventilators for the town drains, so long as ample ventilation as above mentioned is provided for the main sewers, and so long as the sewers are kept thoroughly free from deposit, but further experience will show whether freedom from deposit has been thoroughly secured.

The water-supply of the town has been improved by obtaining water from a pure source.

Whilst it is to be hoped that Memphis may not again suffer from such severe epidemics as have occurred in late years, there must remain for some time a serious ground for apprehension owing to the large extent of subsoil pollution of the site of the city. Because although the old cesspits have been cleaned out and filled with fresh earth, yet there necessarily must still be present in the subsoil a large amount of the polluted matter which has been gradually accumulating in the subsoil for so many years.

DOUGLAS GALTON.

April 1881.

1636
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India Office,
London, 27th October 1881.

Statistics and Commerce,

No.

To His Excellency The Honourable The Governor in
Council Fort St. George.

SIR,

para. 1. I have given instructions for the transmission, through the Stores Department, of 70 copies of the accompanying Report, by Captain Galton on the drainage of Memphis, in the United States America.

2. I request that your Excellency will cause the necessary measures to be taken for the circulation of the copies of this Report to the best advantage.

I have the honour to be,

Sir,

Your most obedient humble Servant,

(Signed) HARTINGTON.

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Drainage of Memphis (Tennessee), in the United States of America.

In consequence of the numerous cases mentioned in the Sanitary Reports for India in which it appeared that economical systems for drainage are urgently required in that country, I was led, whilst in the United States last autumn, to investigate the arrangements which have been adopted at Memphis (Tennessee), where the conditions of the town appeared to present some similarity to those of many Indian towns, viz., the absence of sanitary precautions in the face of a high temperature, and a long period of dry weather, during the summer months; combined with a low financial condition of the municipality.

This latter consideration rendered it imperative that the arrangements which were adopted at Memphis should be largely controlled by considerations of economy. So far as the present limited experience goes, the economical methods adopted have proved efficient.

The main object of furnishing an account of these works is to afford useful matter for the consideration of engineers engaged in Indian sewerage works, and not with any view of suggesting that the system adopted in Memphis should be blindly followed.

The city of Memphis is situated in latitude $35^{\circ} 9' N.$, longitude $90^{\circ} W.$

It stands on the eastern side of the Mississippi river, to the south of its junction with Wolf river. The older part of the town stands next the river, upon a bluff or ridge bounded by a stream called Bayou Gayoso, tributary to Wolf river. The remainder of the town, behind this bluff, is on lower ground, intersected by several streams, which have their origin in springs of pure good water in the country, and which flow into the main bayou above mentioned; and thus the ground on which the town stands is favourably situated as regards surface drainage.

During the short period (little over half a century) of her existence, the city of Memphis has been the theatre of no less than twenty-two epidemic visitations of disease,—small-pox, cholera, yellow fever, dengue, erysipelas, puerperal fever. Her annual death rate, even during non-epidemic years, has rarely fallen below 3.5 per cent., 35 in the 1,000—something more than double the attainable standard of modern cities.

The town had been subjected to visitations of yellow fever in 1867 and 1873. At the beginning of 1878 the city was bankrupt. Its taxable wealth available for the support of the State, county, and city government, which before the Civil War was estimated at \$28,000,000, had been reduced to about \$12,000,000. The population had meanwhile doubled.

Negroes, who, under the system of slavery which prevailed up to the breaking out of the Civil War, had been productive labourers in the cotton fields of the adjoining States, attracted by the excitement it affords, flocked to the city, where at least one third of them were added to the ranks of the very poor, and either as petty thieves or worthless paupers depredated partly upon the industrious few of their own colour, but for the most part upon the thrifty whites. Thus the non-producers, those who consume without labouring, and live without the least regard for the obligations of good citizenship, were increased to the proportions of a small army. The debt amounted to \$5,500,000. The summer of 1878 was intensely hot.

A case of yellow fever was reported to have occurred at New Orleans on the 13th of July 1878. At the beginning of August there were indications, in New Orleans, that the epidemic was likely to be of a very aggravated form. The population of Memphis became seriously alarmed, and quarantine was established round Memphis in the beginning of August.

On the 9th August yellow fever was reported to have broken out at Grenada (Miss.). The first case of yellow fever occurred at Memphis on the 14th August. There were 22 cases on the 15th and 33 on the 16th. The population of Memphis at that time was between 40,000 and 50,000 inhabitants. More than one half of this population then took alarm and left the town.

The medical estimate puts the total population which remained during the epidemic at 19,600 and the total sick at 17,600. The deaths were 5,150, a little less than one third of the whole population. Members of the "Howard Visiting Corps," who have resided in the city many years and know it well, and whose business during the epidemic it was to visit every ward every day, say that at no time were there more than 20,000 persons in the city, if so many, and that, of these, fully 11,000 were Negroes, leaving only 6,000 white people. Of the 14,000 Negroes, 913 died of the fever, and of the 6,000 whites 4,201 died, being 70 per cent. of the whole number of the whites. Not more than 200 white people escaped the fever, and most of these had suffered from yellow fever in previous epidemics.

The sanitary condition of the city was disgraceful in the extreme. There were no public sewers, and the refuse and filth were delivered into cesspools and private vaults, while not a small portion found its way into the gutters of the public streets, and these during a prolonged dry season became reeking and noisome, and emitted the foulest odours.

Some years ago many of the streets were paved with wood pavement, but it was very much decayed, and readily absorbed some of the liquid filth that flowed over the rotten wooden gutters, and in course of time the streets became so permeated with it that the periodical flushings of rain were utterly failed to cleanse them. The street surfaces were then the constant source of poisonous animalcules, which none of the inhabitants in the city limits could avoid, as the subsoil was impregnated with the filth and excreta of the community.

There was no organized scavenger system, nor any means by which the refuse and garbage could be daily carted away. The great accumulations of dirty goods were decaying upon the surface. The Bayou, dividing the city, and which was the receptacle of the contents of privies and water-closets, was sluggish and without sufficient current, owing to a want of water, and to the fact that there had been scarcely any rain for several weeks. The carcasses of dead animals were decaying in many parts of the city, and pools which had formed at the abutments of the several bridges were stagnant and covered with a scum of filth, emitting a deadly effluvia. The cellars of the houses in the leading thoroughfares were also stables, in which were manufactured noxious gases which stole unperceived and made the night air an almost killing poison.

The privy pits in Memphis are so deep that they reach the sand substratum on which rests the great clay bank known as the Bluffs.

Through this sand the water of the Mississippi finds its way at every great rise, so that in many places the gradual advance of the Mississippi may be actually traced by the rise of the excreta, which, when the river is low, are drawn after the water through the soil.

In the early days of Memphis, privy vaults or pits were properly dug, and were made deep enough to reach this sand, as a means of disposing of the filth of the night-soiler.

There is an old city ordinance still in operation which was very defective. For instance, it says, whenever a privy vault is filled within three feet of the surface it must be emptied. The result in many instances is, that only excreta was taken out to evade the law, although many of the vaults are from 50 to 60 feet deep.

Another plan has been resorted to called "house-cumpling"; that is, a new pit is dug by the old one, so close that they merge into one. Owing to such a disregard of cleanliness there were privy pits and vaults in Memphis, in which had accumulated excreta, and even kitchen filth, for from 10 to 40 years.

A general idea of the condition of the houses may be gathered from the description of a detailed examination of one of the blocks of buildings made by the National Board of Health.

"This block contains 202 houses, the average age of which was about 20 years. There were 65 cellars. In 37 of these there was little or no provision for ventilation. 54 of the cellars were damp or wet; the walls in some cases soaked with leakage from privy vaults; in other cases stagnant water, 6 inches deep, was standing on the floors; in some cases disused cisterns contained foul water. There were 164 privies, of which 32 are in cellars, 48 in the other parts of the houses with vaults beneath; 48 adjoin houses, and the remainder are in the yards, at distances of from 3 to 40 feet from living rooms; 23 houses are without privies, the occupants using a neighbouring one. Of the total number less than 40 are in good sanitary condition. The prevailing evils were deep vaults, full or nearly so, and leaky and broken vaults, allowing the

contents to soak into the ground; dilapidated sheds; rotten floors and seats, old hogs-heads sunk into the ground for vaults, and

Of the yards, 80 were filthy and unclean, containing more or less decomposing organic matter soaked with stable and human ooze and faecal matter. 48 of the yards were fairly good, being brick-paved and drained with brick gutters. The drainage was entirely surface. 64 houses had brick drains, of which 24 were in good condition, and 40 foul, broken, and clogged up where they run under the houses from the rear to the street gutters in front. The drainage of the remaining 133 lots was either by dirt gullies or left to the natural slope of the ground."

The water-supply of the town was not satisfactory. It was partly derived from cisterns in the houses, partly from a large rain-water reservoir, and partly pumped from Wolf river, and delivered by pipes to the hydrants. The cisterns were for the most part built in cellars, and as a rule from 8 to 20 feet of the privy vaults. It was estimated that eight out of ten were pervious to water. The soil is of a porous character and seepage is constantly going on, especially in wet weather. Owing to this seepage the vaults and cisterns are brought in communication. So unmistakably is this the case in many cisterns, that the rise or fall in the cistern from seepage equals that in the privy vault.

Owing to the great depth of these privy vaults and the mild winters, the temperature never falls low enough to destroy animal life (animalculæ). In summer the temperature cannot be high enough in these vaults to create very rapid changes.

An examination of the water-supply was made in 1879 by the National Board of Health. There were 50 waters examined, of which 36 were from sunk cisterns, one from the round tank or reservoir, five from wells, one from Elmwood Creek, six from Wolf river, and one from Mississippi river.

Of the 36 cisterns, 10 were in sound condition, and 26 leaked. The waters they contained may be classified as follows:

	Fair.	Bad from foulness of Cistern.	Bad from infiltration of Sewage.
Ten sound cisterns	3	—	—
Twenty-six leaky cisterns	3	2	10
	6	2	10

These 36 were believed to be above the average of Memphis cisterns, as nine of them belonged to the public schools, while more than a dozen of the samples were sent in by inspectors, the others having been furnished from the residences of gentlemen who attach importance to the water supply of their households, and endeavour to keep their cisterns in good condition.

The sample from the tank or rain-water reservoir was good.

Of the wells four were organically pure and one exceedingly impure, the last showing that a leak in the brick lining of the well may admit of sewage infiltration as readily as one in the brick wall of a cistern. In some of the pure wells the amount of earthy and saline matters was such as to cause a doubt as to their wholesomeness. Of the running waters that from the creek at Elmwood Cemetery was very impure. A sample from the mouth of Wolf river, taken after recent rains, was exceedingly impure. A sample from the same river furnished by the city supply before rain was also exceedingly impure. Three samples from Wolf river, as stored in cisterns when the river was low and free from turbidity, were of good quality. One sample from the river was low and free from turbidity, when passed through a charcoal filter proved exceedingly pure. One sample of Mississippi river water, taken after the rains from a point half a mile above the mouth of Wolf river, proved a fair water, being but slightly inferior to that delivered in Washington as the city supply.

After the cessation of the fever in 1878 the city underwent considerable purification. The streets were cleansed, the houses ventilated and exposed to the cold of the winter, and artificial means of disinfection were applied.

To outside appearance the city thus cleansed would have compared favourably with other cities north and south of it which were free from fever; but the privy-pits and vaults, the impure sewers and polluted subsoil and water-supply remained.

In the summer of 1879 there was a fresh outbreak of yellow fever. The first case

was reported on the 9th of July. The disease did not become epidemic till about the 10th August.

The estimated population of Memphis at the commencement of this epidemic of 1879, according to the reports of Colonel Cameron, Superintendent of Camps, was 38,400. The greater part of this population, viz., 24,800 persons, were then moved out into camps, situated within 5 to 10 miles of the city, and the population of the city itself was thus reduced to 13,600, of which about two thirds were blacks. Prompt and active depopulation appears to have prevented a repetition of an epidemic like that of 1878.

The following are the cases reported and the deaths:—

	White.	Coloured.	Total.
Cases - - -	863	679	1,532
Deaths - - -	379	106	485

During this epidemic the "National Board of Health" made a survey and report upon Memphis.

The following are the chief recommendations they made:—

1. The systematic opening up and airing throughout the winter of every house within the city limits, the thorough exposure to sun and air of all textile fabrics, bedding, clothing, carpets, upholstered furniture, &c., the destruction by fire of every article suspected of being infected by exposure to yellow fever during either 1878 or 1879, and of all accumulations of rag and old stock, and second-hand clothing, the usual contents of junk shops and second-hand stores.

2. The absolute destruction of about 100 specified houses and groups of buildings as unfit for occupancy, and infected beyond the possibility of renovation; the vacation of a still larger number, pending alterations necessary to fit them for healthful occupation; and the passage of an ordinance forbidding the future erection of buildings unprovided with proper means of subventilation and other sanitary requirements.

3. A radical change in the water-supply involving the total abandonment of all existing wells, and many of the underground cisterns, and the substitution of Mississippi river water for the water of the river, now supplied by the water-works.

4. An equally radical change in the disposal of excremental and other refuse, and domestic and manufacturing wastes, this to be begun at once by emptying, disinfecting, and filling with dry clean earth all privy vaults, and substituting therefore some cheap and convenient form of deposit.

5. The complete sewerage and subsoil drainage of the town.

6. The reclamation of Bayou Gayou and its tributaries by the acquisition of the ground on either side for a sufficient space to prevent fouling of the contained waters, and the erection of a dam, with sluice valves and a steam pump, to keep the Mississippi river from flowing up into the town in high water, which at present is a potent source of soil saturation.

As regards the streets, the Board recommended that with the exception of those devoted to heavy traffic, it was advisable that the streets should be constructed of Paducah gravel, laid on a properly shaped road. Further subsoil drains had been established, and that the gutters and curbs should be made of concrete. And they added that few places possessed greater natural advantages than the city of Memphis for drainage, removal of excrement, garbage, &c., to secure that healthfulness so necessary to commercial prosperity; and that by carrying out the above recommendations to commercial prosperity; and that by carrying out the above recommendations and by availing itself fully of what was then known as the causes of disease in excess, and the methods of avoiding or destroying these causes, Memphis might soon become one of the healthiest cities in the valley of the Mississippi.

The municipal authorities set to work immediately after the epidemic of 1879, to remove the sources of impurity pointed out by the National Board of Health.

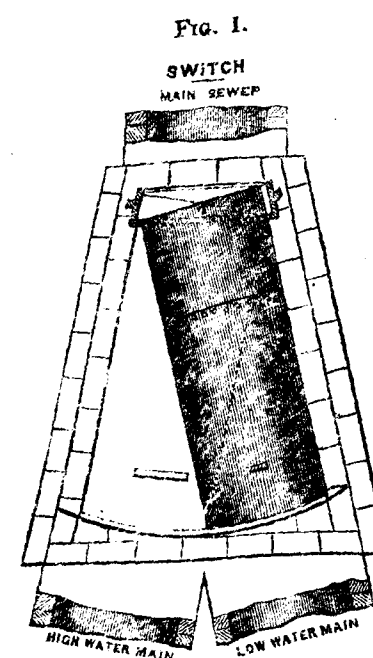
They obtained plans for the drainage of the town, but those drawn up upon the

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ordinary systems of town sewerage. In the bankrupt condition in which consideration. Under these circumstances the well known sanitary engineer, proposed the configuration of the town of Memphis sewerage-water alone, rigidly excluding water necessary to furnish conveyance being introduced from another source.

The system he proposed was estimated. This estimate included not only the work; the laying of about 40 miles of the bayou, by shutting out the high water proper valves, and a steam pump to pump level of the river was high.

The accompanying plan shows the arrangement of the sewers. (See map.) The new system has an outlet through the jail, which delivers into Wolf river, during high stages of the river, when it would cause a liability to deposit. The



comparatively slight fall, that of the lateral sewers are almost invariably they serve as the outlets for more than to 8 inches.

So far as the conformation of the they have been laid in the alleys and cation with the backs of houses, and under the buildings, the plumbing is universally at the rear. In some cases accommodate houses so situated suburban being, where only one or two houses are

The sewers were laid on an average buildings had cellars, this depth was crossings, where the sewer came so near the vitrified pipe sewer at times when pipe were used.

At every point along each line where a house may be built, an oblique junction being temporarily closed. Wherever a sewer from injury at the hands of careless up the street, and to make the connection

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estimated to cost from 300,000. to 600,000. found itself, expense was a material Waring, of Newport (Rhode Island), under the special circumstances of the sewers should be constructed for and subsoil drainage, the amount of each solid matter as enters the sewers

about 50,000. only. sewerage system, but also other sanitary drainage, and also the reclamation of the Mississippi by means of a dam with the bayou during the period when the

arrangement of the sewers. (See map.) large iron pipe draining the county outlet is to be used permanently only outlet water in the long permanent main permanent main discharges below low water Mississippi river, at the foot of Winchester the mouth of Wolf river. Its lower iron pipe, with lead joints, and so much in high and dry ground is of brick. Its diameter 20 inches. The flow can be turned at the jail sewer or into the permanent main, by a sliding section of pipe or switch working in a chamber. (See sketch, Fig. 1.) The 20-inch main continues as far up as Jackson Street; here it is to receive a 12-inch vitrified pipe main along the east side of the bayou, and a 15-inch vitrified pipe main west of the bayou.

The division of these mains beyond Gayoso Street and the main branches are of smaller pipe. There are man-holes along these main lines, by which their condition may be inspected. These two mains (12-inch and 15-inch) constitute the outlet channels for the area of the city, the lateral sewers enter at courses oblique to the direction of the flow, and the discharge of each lateral, having considerable velocity from its rapid descent, will increase rather than retard the velocity of the current in the main, which it was necessary to lay with a fall of one inch being only 2 inches in 100 feet.

The lateral sewers are almost invariably 8 inches in diameter. In rare cases, where they are more than a thousand feet in length, they are increased

and the division of property would admit, the streets, thus affording direct communication with the necessity for carrying house drains of houses at Memphis being almost do not run through to the alley, and to the streets, these sewers have been laid in the streets, these

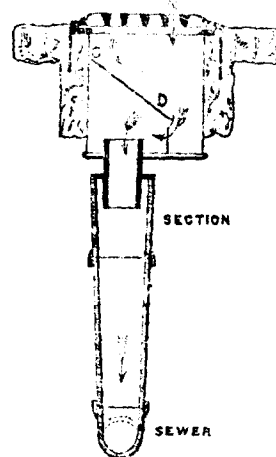
accommodated, only 4 inches in diameter. at 6 feet below the surface; as but few are sufficient. In some cases, as at street the surface as to endanger the crushing in of the ground is very soft, a few lengths of iron

is at all likely that at any future time a house is built in with the sewer, its mouth is now standing, in order to protect the men, to avoid the necessity for digging up the street, and to make the connection as costly to the householder, a four-inch

branch is carried up to the lot line of ground, which in that climate is a small frost. By this arrangement the public sewer connection at the lot heretofore to make the connection by a piece of the same diameter as the house below its top. The house connection the top and bottom lines being tangent, house drainage is delivered at the tendency to increase its velocity, very top.

The lateral sewers have no man-holes with the surface of the street, except there is a fresh air inlet, which may be a sewer. This fresh air inlet has a cover a large and very open grating, beneath dirt from falling into the sewer, this

FIG. 2.
FRESH AIR INLET



which it may give a clear air inlets in fundamental connections that continued with inches in diameter connected. It made a mistake every occupant be not less than the 40 miles ventilator for

The rain-water from the roof serve solely

manufacturing establishments, stable, connecting a house of any size with the diameter. This is amply large for a gauging of the flow of the main sewer height of the season, at the hour when of water was being discharged, and showed a stream barely sufficient to fill rigid adherence to this limit of four inches clog the six-inch sewer, and throw it upon the householder, as he alone will

At the head of each sewer there is a 112 gallons. This tank is built of brick above the level of the head of the sewer from the public water-supply, barely furnished with Field's automatic siphon flow, is sure to be brought into operation pipe; the whole amount of water in the 40 seconds), and rushes down the sewer substance, of whatever character, the

The flushing stream, according to the more than half full 900 feet from the top of the fall of the sewer. At a fall of 1 inch point where the natural flow is able to the end of its own sewer to flush.

It is thus immaterial whether all the flush tank is one of the essential parts of it the use of any sewers not receiving

Aside from this means of assurance, accumulate to a dangerous extent, but

three feet below the surface of the to protect house drains, as there is later, in making his connection, finds the property. It has been the custom house drain and the sewer by a branch sewer above its bottom and in Memphis are funnel shaped, circumference of the sewer, so that the of the flow of the sewer, with a ventilation of the sewer reaches its

holes, or communication of any sort near the lower end of each, where the inspection of the working of the the surface of the ground through a plate of iron is placed to prevent into a receptacle at the side, from removed (see sketch, Fig. 2). This be lifted to a vertical position to sewer below. Aside from the fresh a current for ventilation, it is a ordinance regulating house connections, of whatever character, shall be opening trap, by a pipe fully four above the top of the house so connection is compulsory, and as it is to have at least one water-closet for the work is completed there will be four-inch ventilating pipes for the city, being an average of one sewer.

on the surface of the ground or not admitted to the sewers. They of the waste water of houses, no circumstances is the pipe connection to be more than four inches in diameter for establishments. For example, the Union Hotel in Saratoga in the thought that the largest amount were 1,300 inmates in the hotel, one half inches in diameter. A exclusion of matter, enough to of excluding rubbish or grease from his neglect.

tank, having a capacity of about the surface of the ground, but by a constant stream of water once in 12 to 24 hours. It is (Fig. 3), which, however slight the is filled to the top of its outlet discharged rapidly (in from 35 to sufficient to carry before it every may have been capable of admitting. made in Memphis, fills the sewer distance must, of course, depend on is ample to wash all filth forward to a of it. Each tank has only the dead

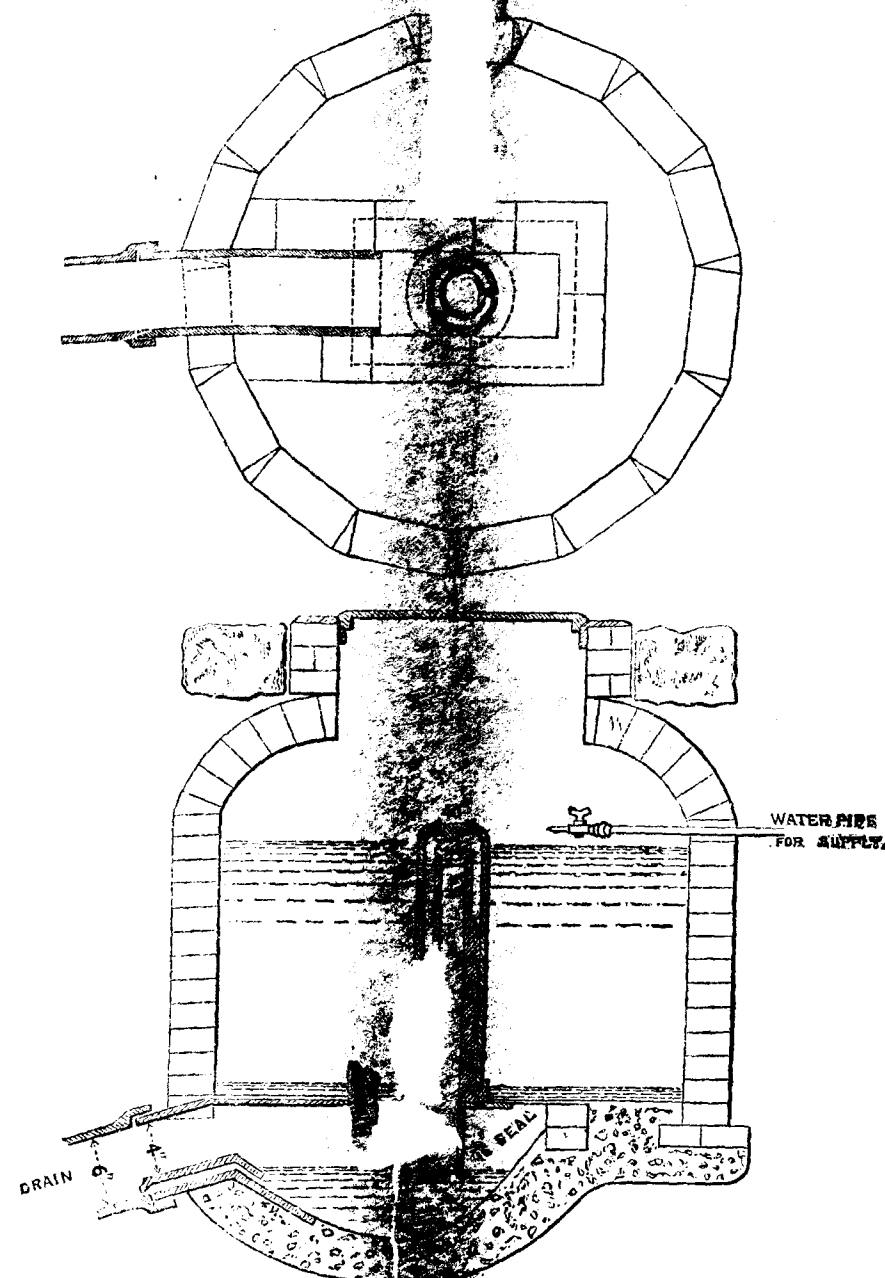
go off at once or irregularly.

of the combination; indeed without it would be extremely unsafe.

of obstructions before they can the flush-tank has the further very

important effect of carrying forward to matter which, if allowed to remain

let, at least once in 24 hours, all organic matter, would enter into a dangerous



decomposition, for even in a 6-inch sewer there is a tendency to deposit faecal matter and other solid substances toward the ends of the sewers where the regular flow has not yet accumulated sufficient velocity to sweep them forward. In the Memphis works such deposits are rendered impossible, and the production of sewer-gas as a consequence is substantially prevented.

Some of the details of the construction of these sewers are different from those in common use. Ordinarily pipe sewers are laid from the lower end of the drain upward, so that water accumulating in the trench is carried off by the sewers as they are laid. But it is impossible to make a tight joint when the pipe is required to carry water before the cement hardens. Therefore, with the small diameter here used, absolute cleanliness is very important. Therefore the laying of each line was begun at its upper end, every effort being made to make soil-water absolutely. This was effected by a system of subsoil drainage carried on in connection with the sewerage. Agricultural tiles, varying from 1 1/4 to 3 inches diameter, were laid in the trenches by the side of the sewers. The joints were covered with paper, to prevent the loose filling from stopping the joint. In very wet soil it was necessary to lay these tiles in advance of the sewers by digging a narrow trench below the grade of the sewer. Into this trench the tiles were laid and covered with boards to prevent their being disturbed while laying the pipes. These subsoil drains were provided with an outlet into the bayou.

DOUGLAS GALTON.

1636
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Public Department
 Secretary of State
 No. 25.

C. No. 2455.

Public Department. 14

1636
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 15
 PROCEEDINGS of the MADRAS GOVERNMENT.

of 30th Nov 1851, No 1636 Read the following

Distribution of 70 copies
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 in the United States of America

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Surgeon General with his staff of Madras	15
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Sanitary Com? do	40
Govt. Office	7
	70

W. H. R. H. H.

with
 1636
 15
 Attest Secretary

Oct. of 1880. *Stanzas.*

To

W. H. C.

30th

Dated *28th* 1880, No. 1636
Recd.

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