MICHAEL DONAHUE,

FOUNDER DAVENPORT WATER WORKS.

"You never miss the water 'till the well runs dry."

A DESCRIPTION OF THE PLANT

OF THE

Davenport Water Company,

BY

JAMES P. DONAHUE.

ILLUSTRATED.

1892.
Egbert, Fidlar, & Chambers, Printers,
Davenport, Iowa.

To the Generous Citizens

Who have been foremost in encouraging the

Improvement of our City, and who have always aided the

Water Company in its advancement and enterprise,

This Book is Respectfully Dedicated.

The Davenport Water Works.

SO well has the excellence of our Works become known, that we are in almost daily receipt of letters from all parts of the country, and even several foreign cities, asking for descriptive information, and especially of our magnificent filter plant. To impart a fair impression to all those interested sufficiently to ask it, this little book has been compiled; also, that it may serve as a souvenir to all those who favor us with a personal visit.

In preparing this work, it has not been the intention to give an elaborate detailed description of the plant of the Davenport Water Company, but rather a concise article, with such short bits of history as may seem appropriate.

EARLY HISTORY.

So closely has his name been identified with these Works that this book would be incomplete without reference to the Hon. MICHAEL DONAHUE, the founder of the Works.

Mr. Donahue came to Davenport in 1856, engaging in the manufacture of threshing machines and other agricultural implements, and conducting a large foundry and machine shop. In 1872, when the question of Water-Works was being discussed in the city, he applied for a charter, and the same was granted. Immediately he associated with him his brother, Col. PETER DONAHUE, of San Francisco, Cal., and organized the Davenport Water Company; Michael Donahue serving as president, constructor, and manager of the Works until his death, October 2d, 1884. While the Works did not prove a financial success during his life, his aim to place in Davenport one of the finest and most complete Water-Works systems in the West was crowned with success, and will stand as a monument to his memory to the last generation.

TO THE STRANGER.

First, a word about our beautiful city. Davenport was selected as the site of a great city because of its natural beauty

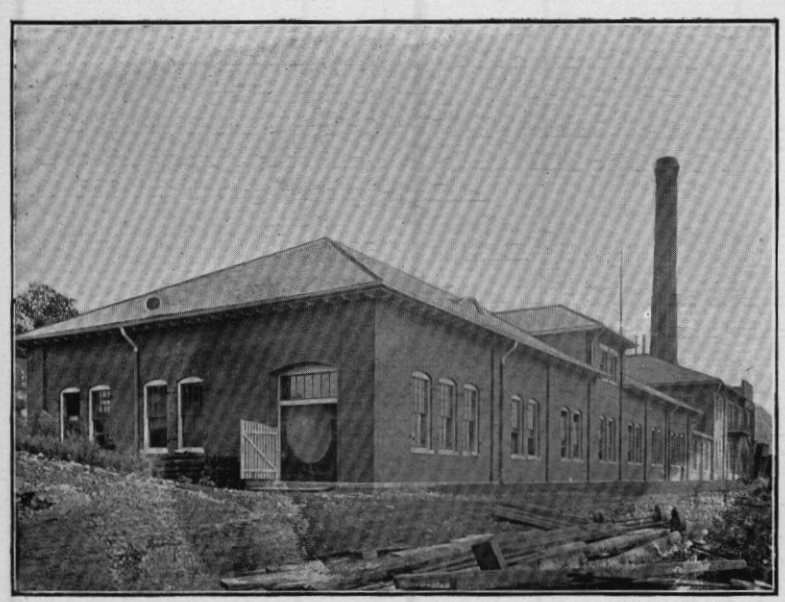
and picturesque surroundings. Pretty waving bluffs follow the river east and west, and between the line of these and the river is a triangular-shaped plateau, narrowing at the eastern limits of the city, and large enough to accommodate a population of 150,000. Here, where the busy factory wheel, ever grinding, employing thousands of willing hands, the high office buildings and store blocks, and the hustle-bustle activity of energetic business men predominating on beautifully paved streets, is located our promising city of upwards of 30,000 people. Handsome homes dot the bluffs, away from the noise and above the dust and smoke of the active city. River views scope the country brought within the range of the eye, furnishing a variety of scenery unequalled.

As a business center, Davenport stands to-day unequalled, with its five trunk lines leading north, south, east, and west; also, the great Mississippi river, with its connecting lines of steamboats. The Illinois and Michigan canal, now building, will be a great advantage in transportation facilities. The advantages of our city as a wholesale center are shown by the fact that there are 25 houses of this kind with a capital of about $4,000,000, and sales for the past twelve months of over $12,000,000. Banking capital and deposits of the financial institutions are greater than any other city in the state of Iowa. There are four National and four Savings banks, with a combined capital and surplus of $2,000,000, and deposits of $10,273,000; this speaks for itself.

THE WATER-WORKS.

The system comprehends a magnificent plant, in which about $1,200,000 have already been invested. The Works comprise two well-equipped pumping stations; the filter plant; a 5,000,000 gallon reservoir; and about 37 miles of water mains, varying from 6 to 16 inches in diameter. There are 400 public and private fire-hydrants. The maximum pumping capacity of the Works is:

Pumping Station No. 1 . .	11,000,000 gallons daily.
Pumping Station No. 2 . .	7,500,000 gallons daily.
Total	18,000,000



EXTERIOR VIEW OF FILTER HOUSE AND PUMPING STATION NO. 1.

THE WATER SUPPLY.

An all-important feature to a Water-Works, and to its consumers, is its source of water supply. About three years ago, to better serve its consumers by supplying a clearer water, this company made a careful and complete investigation of all the sources of supply in the vicinity of Davenport, aided by CHESTER B. DAVIS, C. E., of Chicago, probably one of the most prominent consulting engineers in the west. The possible sources of supply seemed to be limited to artesian wells; to sand and gravel deposits about two miles southwest of the city, between the bluffs and the river; to the valley of Duck creek; and to the Mississippi river. Artesian wells, owing to the presence of saline matter giving a positive taste, which would be objected to by many, its extreme hardness, and the fact of its containing mineral and other ingredients which would without doubt make it objectionable for culinary and mechanical purposes and steam uses, were reasons sufficient why the same should not be considered seriously as a source of supply. The company carefully investigated the artesian supplies of many other cities before deciding upon the question.

The sand and gravel deposits found below the city evidently would yield a considerable supply of water, but the extreme hardness of the water, and the objectionable surroundings, of its closeness to the slaughtering and packing-houses, were sufficient to condemn this as a permanent source of supply.

The existence of an ample subterranean supply in the Duck creek valley was yet unproven. A yield of from 3,000,000 to 5,000,000 gallons of water per 24 hours from subterranean source is very large, not often found, and but few are thoroughly reliable and permanent.

The Mississippi river was objectionable in only one particular; during portions of the year it held large amounts of earthy matter in suspension, and to clarify it by subsidence would only have been difficult and require a considerable and objectionable length of time. The results of chemical analysis at that time by DR. RADENHAUSEN showed no objectionable amount of impurities in solution, but that they were all in suspension. The supply of water from this source being practically inexhaustable at all times, and aside from impurities natural to water, and to

any stream flowing through a country adjacent to the Mississippi river, the objectionable features of this water are very slight.

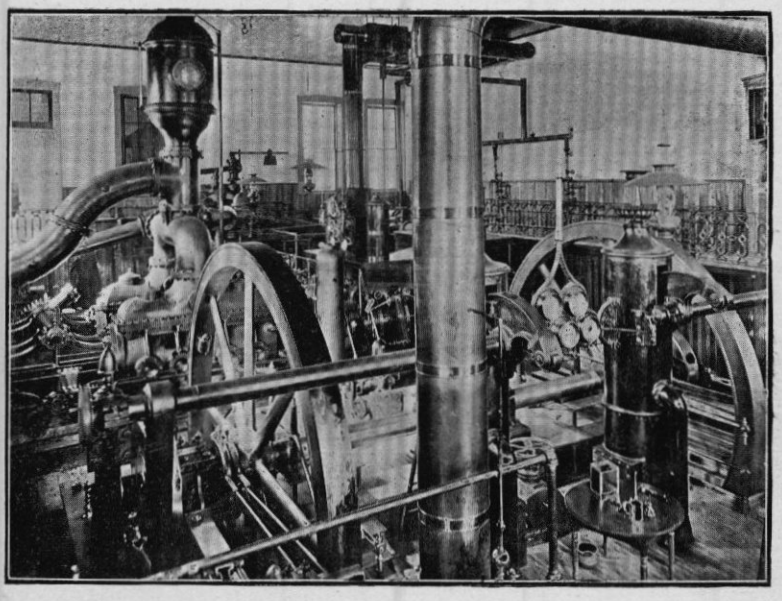
The possibilities of sewage contamination are too remote to ever be a cause of anxiety, and the natural agencies tending to produce purer water — oxidation, dilution, contact with earthy matter, etc. — are here quite active.

A careful study of the mechanical appliances for filtration necessitated considerable travel, and I visited Philadelphia and other eastern cities, Terre Haute, Elgin, Chattanooga, Cairo, Atlanta, Little Rock, and other western and southern places where mechanical plants of different make were in operation. I spent from two to ten days in each of these places, fully and carefully investigating each and every detail connected therewith, and was fully convinced of the practicability of the different systems for the purpose for which they were designed. It was then my unbiased opinion, and also that of my associates in the Davenport Water Company, that the Mississippi river was the best source of supply for our city, and that the same should be subjected to mechanical filtration, assisted, when necessary, by chemical precipitation, or so-called "coagulation."

The water is delivered into our pump-wells through a tunnel built under the bed of the river, and at present (May 1st, 1892) being extended 750 feet further out, to near the channel of the river, about a mile above the government bridge, and above all contaminating sewage of the city. The water here, with its current seldom less than five miles an hour, rushing swiftly over the Rock Island rapids, evidences practically complete aeration, and, as mentioned before, oxidation, dilution, etc., which all tend to purification.

The pump-wells are built of heavy masonry tightly cemented, and are about 30 feet deep. Between the two wells are heavy coarse-mesh screens, to screen off fish, bark, chips, leaves and all debris from entering the pumps. Over these wells is built a handsome frame structure called the Gate House, in which is all the gearing, etc., for handling the large tunnel gates, a large steam engine for pumping sand, etc., which accumulates in the wells.

From these wells, after the water has been well screened, the pumps of Pumping Station No. 1 take the water and deliver it through the filters, under direct pressure, to the city mains and to the reservoir.



View of Engine Room, Pumping Station No. 1.

PUMPING STATION NO. 1.

This station comprises the original Works, and is situated on the Mississippi river, about a mile above the government bridge. At this station is located the Filter House, and the buildings connected present a mammoth structure of brick, being 264 feet long by 68 feet in width. The machinery here consists of a high-duty compound condensing duplex Worthington pumping engine, capable of delivering 6,000,000 gallons of water per day against a head of 345 feet. It comprises all the latest improvements, and is pronounced one of the finest and smoothest-running pieces of machinery in the country by all who have seen it. There is also a 5,000,000-gallon set of pumps, of the Clapp and Jones type, built by the late Michael Donahue, recently remodelled at considerable expense, and in first-class condition, being in daily use.

The engine-room is handsomely but plainly finished in hard southern pine, and presents a beautiful appearance, being at all times kept in excellent condition. There are at this station five large steam boilers; two 66 inches in diameter, twenty feet long, and three, 60 inches by 18 feet. These boilers are ample to furnish twice the amount of steam required, and always permit of a reserve set.

At this station is the large steam-whistle, not now used, but still well remembered by old citizens who oftentimes heard it. It is a duplicate of the whistle that was used on Machinery Hall, Philadelphia Centennial, 1876, and was at that time, and probably is now, the largest steam gong in the United States.

THE FILTER PLANT.

The filter plant consists of ten double filter-shells, each 7½ feet in diameter by 32 feet long, built of mild homogeneous steel of 60,000 pounds tensile strength, of five-eighths of an inch in thickness, which stood tight under a steady proof test of 200 pounds per square inch. The size of the filters is such that while nominally of a capacity of 6,000,000 gallons per 24 hours, their actual capacity is over 7,500,000 gallons for that time; over 50 per cent larger than any filter plant in use, and without fear of contradiction it can be said that the city of Davenport has the largest and most expensive "mechanical filter plant" on the face of the globe. There may be larger settling basins, but nowhere a larger pressure filter.

The filters are so arranged that any one of them can be operated separately or the whole battery collectively. The filters are about three-quarters full of white sea sand, amounting to about thirty car loads, brought from Horn island, in the Gulf of Mexico. The peculiar nature of this sand is, that each grain is of almost even texture and a perfect crystal. Ordinary river or building sand, being porous, would tend to make it unfit for filtering purposes. When water contains microbes, sometimes so infinitesimally small that it would require our most powerful magnifying glasses to detect them, these little disturbers might have a tendency to lodge themselves in the pores of the porous sand and die and rot, and in a very short time the sand would become a bed productive of a variety of diseases, rather than a purity of water. For this good, sufficient, and all-important reason, then, is the sharp, solid, and anti-porous crystal sea sand of Horn island necessary, and an all-important factor for good filtration. This sea sand, however, is found on Long island, and other sea islands and shores.

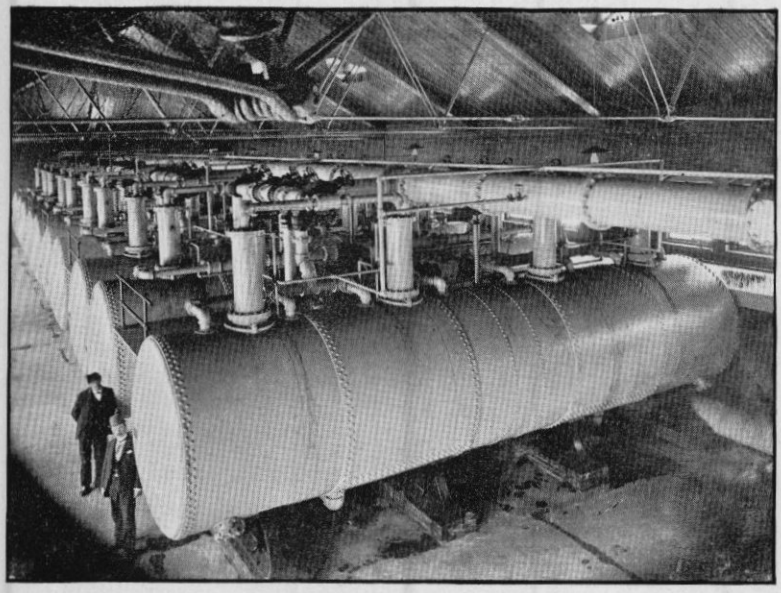
The water is forced by the pumps through 20-inch feed mains into the filters, passes downward through five feet of sand, thence through a peculiar-shaped screen, made of extremely fine slits sawed through cylinders of heavy, seamless tubing, made of composition metal, thence out into the mains, to the city, and the reservoir to the hills.

The process renders the water when taken from the river, even at the highest floods, as bright, clear, and sparkling as spring water.

The sediment and other matter which is removed from the water is retained for the time in the filter on the top of the sand, and to remove this quickly and thoroughly with the highest economy and the greatest certainty, is the chief feature of the excellence in a filter plant.

The method followed by our system during the progress of washing is in the shape of thousands of fine powerful jets, and to apply them directly at the place where the dirt accumulates, and to wash at the same time by reversing the current of water from the bottom of the sand bed, some five feet below the surface.

This is accomplished by supplying the water to the filter through horizontal perforated arms attached to a central vertical



INTERIOR VIEW OF FILTER HOUSE.

pipe attached to a piston, and in such a manner that by admitting the water pressure from the mains to this piston the arms are forced downward and back through the filtering material, applying the washing jets, each 3-16 of an inch in diameter, and under 80 pounds pressure, to every grain of sand in the whole mass, throwing the whole into violent agitation, thus scouring the sand completely clean, and washing the dirt and sediment accumulating off through a drain into the river again below the Works. The thoroughness of the work and the rapidity of the operation are such that it requires less than five minutes to wash a filter, and the mechanism is so simple that there is scarcely any liability of it getting out of order.

Another feature, and by no means an unimportant one, is a process of sterilizing the filter and sand-bed of any possible contamination from microbes, fungus or mossy growth, microscopic algæ, or of microscopic organisms belonging to the class called infusoria, albuminoids, and impurities of this nature, should they be contained in our river water, but which we believe, and with good reason, when taken at proper distances from the shore, is as free from these impurities as is most water; still, in the construction of this plant it was our aim to guard against any of these possibilities. Now, should the water contain any of the impurities just named, and should the vicious little microbe even show resistance to our ordinary method of washing, and should it be possible for him, not finding a hiding-place in the anti-porous sand, to cling to the surface of our filtering sand with sufficient strength to resist the powerful water pressure when washing, then we can rid ourselves of his disagreeable presence, first, by draining our filters frequently, then turning into them through pipes connected to a double battery of steam boilers, built for the purpose, powerful jets of super-heated steam, which in a remarkably short space of time render the sand-bed and our filters a very hot resting-place for him. So hot do the filters become, that it will blister the painting on them, and, beyond any doubt whatever, kill all animal or vegetable life therein.

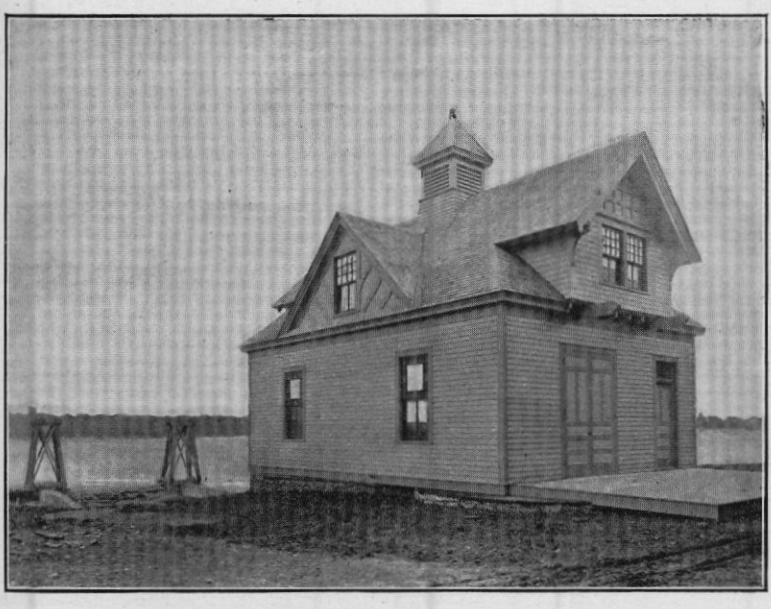
One more all-important thing, and the one that by its use makes mechanical filtration possible, is the coagulation and the use of coagulants in the process of filtration.

By coagulation is meant the addition to the water of certain astringents, notably alum, sulphate of alumina, or per-chloride

of iron in sufficient quantities to deprive all the sediment, no matter how great in amount, of its sticky nature, and change it into a lighter floculent condition, whereby the same can be easily arrested by the sand-beds in the filters. Coagulation is accomplished, when necessary, at Davenport by using about three-eighths of a grain of sulphate of alumina per gallon of water. This ratio can be better illustrated by saying that a pound of sulphate of alumina contains 7,000 grains; a gallon of water weighs about eight pounds; then, if one grain was used to a gallon of water, which seldom occurs, the ratio quantity would be 1 1-56 thousandth part of alumina to one part of water; and I am of firm belief, after careful and practical tests, that from 70 to 90 per cent of the alumina in solution injected into the water before filtration is absorbed by the matter in suspension, forming a coagulated mass on the sand-bed, which is washed out when cleansing the filters. Therefore I will assume that when three-eighths of a grain of alumina is used to a gallon of water, probably less than 30 per cent of the three-eighths of 1 1-56 thousandth part of the same leaves the filters in the filtered water, and so small is that amount I doubt if the ablest chemist that ever existed had instruments or contra-agents with which he could detect its presence in water filtered by this process. The only objection to the use of alum that has ever reached my ears, and then only when used in excess, and certainly so large a quantity as from five to ten grains per gallon would be allowable, was the presence of free sulphuric acid contained therein, which objection, if it be an objection, is entirely overcome by the use of pure sulphate of alumina, which is not alum, and which, to my best belief, contains practically no free sulphuric acid.

ALBERT R. LEEDS, Ph. D., Professor of Chemistry, Stevens Institute of Technology, Hoboken, New Jersey, extract from an address made by him before the Rochester Chamber of Commerce, May 12th, 1891:

"All natural water contains in solution carbonate of lime, to which its hardness is due; when sulphate of alumina is introduced into the water it is decomposed by the carbonate of lime, and sulphate of lime is formed and hydrate of alumina is set free. It is a perfectly white translucent jelly. It forms on the surface of the filter-bed in contact with the grains of sand, and when the smallest particle of silt or the bacteria come in contact with it



GATE HOUSE OVER SUPPLY WELLS, PUMPING STATION NO. 1.

they are caught by it and held. It is possible to entirely remove the bacteria from water by the use of this jelly. These filters worked in that manner have been repeatedly tested, and that point has been most carefully established.

"There are some who think no chemical substitute whatsoever can rightly be employed in the purification of water. It appears to me to adopt such a sentiment is to renounce the advantages which the very elaborate study of this question has given us. They say that hydrate of alumina, which is one-fourth alum, is very pernicious to health. If alum ever went into your water supply I would concede the point that it is not a proper thing to use, but it does not go into the filtered water. The alum is so perfectly decomposed that I never have been able to find it in the filtered water; the hydrate of alumina is left behind and the alumina which goes into your water in a minute amount is also present in natural water itself. If you examine the analysis of river water you will find that the water contains naturally some alumina. It is the alumina in the soil which makes spring water so bright. It is the alumina in the soil which makes the water of driven wells filtered water."

So slight is the use of these aluminas that once a prominent physician remarked that he believed that an ordinary loaf of bread contained more alum than did two barrels full of our filtered water, and I can safely add that our people, even in Iowa, are not accused of drinking two barrels of water for every loaf of bread they consume.

PUMPING STATION NO. 2.

The bluff or high service, or all that portion of the city lying above Sixth street, is supplied with water pumped from the Reservoir by Pumping Station No. 2.

The pumping machinery at this station consists of a vertical set of compound Clapp & Jones Pumps of a daily capacity of 5,000,000 gallons, and a 2,500,000 gallon set of Duplex Gordon Steam Pumps. In time of fire the pumps of this station can be changed over so as to pump into the gravity main and give increased pressure for the lower city in case gravity pressure is not sufficient; then, too, in case of large fires, these works, in connection with Pumping Station No. 1, can pump into the mains at their respective ends and supply a deluge of water and more fire pressure than firemen can handle to advantage.

THE RESERVOIR.

Though of but five million gallons capacity, it answers the purposes for which it was designed — a receiving basin for station No. 2 — and holds sufficient water to give the pumping station one or two days rest, if ever required.

MAINS AND DISTRIBUTION.

Years of experience and careful study have demonstrated to the management what and how changes should be made in the system of mains, by increasing the sizes and adding feeders. During the past few years the company has taken up miles of six and eight-inch pipe and replaced the same with sixteen-inch mains, thus bettering the supply by overcoming friction and lost pressure due to the smaller pipes.

OUR FAITH IN THE CITY.

Now that we have given a fair description of our plant, of its magnitude and completeness, the natural question arises: Did this unstinted expenditure of money meet with even a fair return upon the investment?

We answer: So far, decidedly NO.

Why, then, continue this apparent unlimited improvement and expenditure of money? It is only a stranger to our city who would ask this question. Stranger, we are up and doing. We build not for to-day, but for the future. The tide of progress has swept down upon us, and we are ready to meet it. Davenport, with its unequalled location and advantages, with its energetic and enterprising citizens pushing onward, will not stand still. The Water Company is composed of business men of unquestioned ability, who have faith in the future of their city. Can they show any better evidence of this faith than by the constant expenditure of money in its improvement? Every dollar of the stock of the Davenport Water Company is owned in this city, and when we recently placed our bonds on the market the people of Davenport bought every bond. This only demonstrates that we have faith in our city, and our city has faith in us.

A SPRAY FROM OUR NOZZLE.

Let us modestly give just one little toot of our horn. Would it not be natural that those directly interested should

PUMPING STATION NO. 2, AND RESERVOIR.

feel proud of their achievement? Would it be unnatural if we should think that we had the best and purest water obtainable in the city? Let that be as it may, here are a few facts. Read and ponder.

Naturally nearly every one thinks they have the "best well" or "best cistern" in the city. Here is a bad case of "best well:"

"A family residing on Western avenue, near Third street, had noticed for some time that small, black hairs had been in the water drawn from the well. They thought it advisable to make an investigation, which they did, discovering a fifty-pound Newfoundland dog, which had evidently been soaked in the water for a long time, and the hair had begun to fall off." —*Davenport Times, June 27th, 1891.*

It is not necessary to describe the commotion which followed.

SURFACE WELLS.

"Surface wells depend for their main supply of water upon the area immediately surrounding them, no matter what their depth, and these are the wells most frequently used. The abundance of filth in densely populated cities renders the soil unfit for the filtration and storage of water; and surface wells in such soil furnish only a polluted and dangerous supply, as the water is not sufficiently aerated for the oxidation of its organic matter. *These wells are frequently situated in too close proximity to dwellings, stables, cesspools, privy-vaults, and other sources of pollution, and they are therefore sometimes important factors in disseminating disease.*

"Rain-water, as it passes into the earth, extracts from the soil quantities of impurities, like the products of decaying vegetation and the filthy excrement of animals, which it carries down into the circulating currents, and it occasionally happens that the drainage of cesspools and privies finds a direct channel into the well. *The germs from diseased persons thus find their way to the water supply, and some surface wells are nothing more than receptacles for diluted excrementitious matter.*"—*Potable Water, Floyd Davis (chemist Iowa State Board of Health), p. 57.*

CISTERNS OF PURE RAIN-WATER.

"There is a popular idea that rain-water, as it falls, is perfectly free from impurities; but, in fact, the first fall of rain after a drouth is swarming with living organisms, which multiply and

perish, polluting the water with themselves and the products of their decomposition. Even the purest unfiltered air[1] contains myriads of these motes which can be seen in the sunbeam with the naked eye, but they are washed from it by the descending rain. Two hundred thousand micro-organisms are often found in a litre of water that falls at the beginning of a storm, the number being usually greater in summer than in winter. The principal genus of *Bacteria* found in rain-water is the *Micrococcus*, but other genera are also found, nearly all of which are in the stage of *spores* instead of *adults*. Besides *Bacteria*, spores of *Fungi* and other microscopic plants, together with the pollen of flowers and grasses, are found in rain-water.

"The exhalations that rise from decomposing organic matter, and float in the atmosphere, are also carried down by the rain, so that the first rain that falls during a storm is always more or less impure, and unfit for drinking. The British Rivers Pollution Commissioners concluded that 'half a pint of rain-water often condenses out of about three thousand three hundred and seventy-three cubic feet of air, and thus in drinking a tumbler of such water impurities which would only gain access to the lungs in about eight days are swallowed at once.'"[2]—*Potable Water, Davis, p. 53.*

Where, then, will you get good, clean, and wholesome water, if not from the mains of the Davenport Water Company, a company which has spent hundreds of thousands of dollars and employed the best available skill to find and produce and serve you with the best water available? Do you regret the few dollars the water costs you? God has ordained that water in boundless quantity should flow past our favored city, free as the air we breathe; but consider: to render bright and pure that which has become roily, and to deliver same through miles of mains to your house, into your very kitchen and sleeping-rooms, to furnish this convenience ever by your side, means the investment of a big sum of money, in the erection and maintenance of the extensive plant just described. Do you enjoy the luxury and convenience of our water supply? If so, do you regret the few dollars it costs you? Would you do without it for twice the price? If you speak honestly, you must say no.

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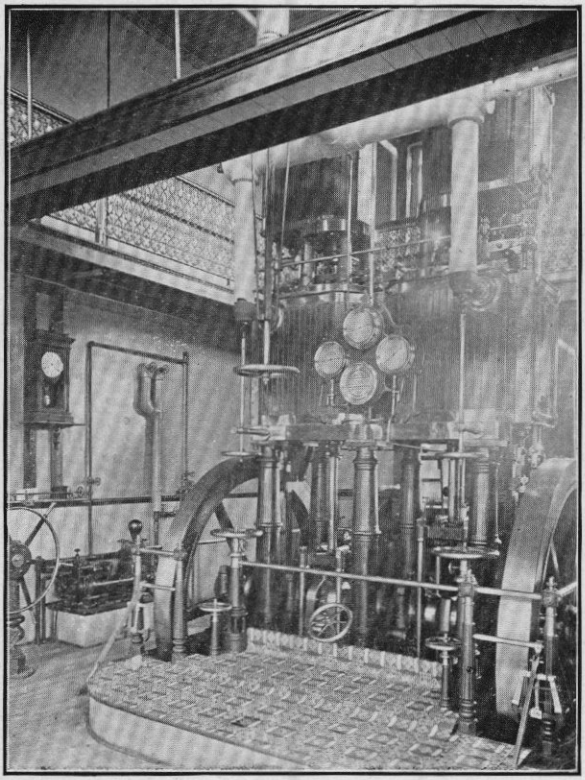
1 *Practical Hygiene*, Parkes, seventh edition, pp. 132-151.
2 *Potable Water*, Ekin, p. 9.



INTERIOR PUMPING STATION NO. 2.

In conclusion, then, I am proud indeed to be able to say that our citizens, without dissent, fully appreciate our efforts in their behalf, and are doing all within their power to assist and help the Water Company to get a fair return upon the enterprising undertaking, and though it will take years to do this, they all stand ready to lend good cheer, and proudly lift up our little cup of drink with the significant toast — "There's no poison in this cup."